

DIMENSIONS OF PIPE, FITTINGS AND VALVES

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DIMENSIONS OF

PIPE, FITTINGS & VALVES

COMPILED AND ARRANGED
FOR
ENGINEERS, ARCHITECTS
AND DRAFTSMEN.

ALSO CONTAINING SOME INFORMATION ON
STEAM HEATING, BATHROOM FIXTURES
ETC. ETC.

BY
W. D. BROWNING.

THE DRAFTSMAN
CLEVELAND, O.

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INTRODUCTORY.

The object of the author is to collect and arrange such dimensions and information which will enable the draftsman, engineer or architect to plan and draw all classes of work which includes pipes, fittings and valves.

No printed matter has been seen which covers as many points as the diagrams and tables here produced and the author feels that he can claim some originality.

The first table, that on globe valves was compiled about 1894 at the shops of Wm. Wallace & Bros., LaFayette, Ind., and the author wishes to express his appreciation for the aid given by the late Mr. Jas. Wallace of that city.

Much credit is due Mr. Frank J. Barra for assistance in compiling and arranging matter as well as for many sketches and tables.

Some of the tables have been taken whole or in part from trade catalogs and proper credit is given on page where used but much has been obtained by actual measurement.

Due to the amount necessary to be placed in some tables, it has been found a difficult task to make all uniform, hence matter had to be adjusted by the printer to fit best.

Since there is now on the market such a variety of makes of fittings and valves, no attempt should be made by the draftsman to claim that measurements should be made exactly to his drawing.

The best fitters always measure to the center of the outlet and a drawing should always be dimensioned that way.

The dimensions here given are taken from fittings actually in use or in supply stores and the careful draftsman will no doupt be able to work in on his drawing such odd sizes as are only mentioned or illustrated,

W. D. BROWNING.

Cleveland, O.

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PIPE, FITTINGS & VALVES.

CHAPTER I

PIPE.

The designing of a sytem of piping is properly the work of a professional engineer or architect, yet the amount of labor and material thrown away under a misapprehension of the subject is enormous.

The fact that so much of the material used is standard, persuades the designer to let the job go without much thought because it is like some other or it was done that way before without looking into the matter to see if the proper materials have really been selected.

This standard system was established by the late Robert Briggs, C. E.. heretofore generally used and now formally adopted by the Manufacturers of Wrought-Iron Pipe and Boiler Tubes in the United States, at their meeting held in Pittsburg, October 27, 1886, and confirmed at a meeting held in New York. May 9, amending the list to exclude 9 inch, which is changed from 9.88 inch to 9.625 inch, outside diameter; also adopted by the Association of Manufacturers of Brass and Iron, Steam, Gas and Water Work of the United States, in convention, New York, December 8, 1886.

For Comprehensive information regarding the subject of standard pipe and pipe-threads, as aplied to American practice, we would refer all who may be interested to the Excerpt Minuets of Proceedings of the Institution of Civil Engineers of Great Britain, Vol. LXXI, Sessions 1882—3' Part 1, containing the paper of the late Robert Briggs, C. E., presented and read after his death, on "American Practice in Warming Buildings by Steam"

The following extracts from the paper of Mr. Briggs (included more fully in the report of the committee on standard pipe and pipe-threads, American Society of Mechanical Engineers, Vol. VIII, transactions), are here presented, giving data upon which the Briggs standard pipe-thread sizes are based:

"The taper employed for the conical tube-ends is uniform with all makers of tubes or fittings. namely an inclination of 1 in 32 to the axis. Custom has established also a particular length of screwed end for each different diameter of tube. Tubes of the several diameters are kept in stock by manufacturers and merchants, and form the basis of a regular trade in the apparatus for gas or liquids. A knowledge of all these particulars is there fore essential for designing apparatus. The ruling dimensions in wrought iron tube work is the external diameter of certain nominal sizes, which

are designated roughly according to their internal diameter. These nominal sizes were mainly established in the English tube trade between 1820 and 1840, and certain pitches of screw-thread were than adopted for them, the coarseness of the pitch varying roughly with the diameter, but in an arbitrary way utterly devoid of regularity. The length of the screwed portion on the tube end varies with the external diameter of the tube according to an arbitrary rule of thumb; whence results. for each size of tube, a certain minimum thickness of metal at the outer extremity of the tapering screwed tube-end. It is the determination of this minimum thickness of metal, for the tapering screwed end of a wrought-iron tube, which constitutes the question of mechanical interest.

"The thread employed has an angle of 60°; it is slightly rounded off both at the top and at the bottom, so that the height or depth of the thread; instead of being exactly equal to the pitch, is only four-fifths of the pitch, or equal to $0.8\frac{1}{n}$, if n be the number of threads per inch. For the length of tube-end throughout which the screw thread continues perfect, the empirical formula used is $(0.8D+4.8)\times\frac{1}{n}$, where D is the actual external diameter of the tube throughout its parallel length, and is expressed in inches. Further back, beyond the perfect threads, come two having the same taper at the bottom, but imperfect at the top. The remaining imperfect portion of the scew thread, furthest back from the extremity of the tube, is not essential in any way to this system of joint; and and its imperfection is simply incidental to the process of cutting the thread at a single operation."

Flat Threads.

Some people discard material on account of the threads being a trifle flat. If one will only stop to reason out this matter, he will see how absurd this idea is. The entire thread on the pipe must be flat, in order to conceive of a leak being produced, and then the leak must traverse the circumference of the pipe as many times as there are threads in contact.

Now, it might be possible to have a leak under these circumstances if no cement were used; but with the use of any cement, or without cement but with the smallest particle of perfect thread, this could not occure.

With regard to the small grooves that somtimes occure in threads due to the weld not being perfectly brought up, this is another feature on account of which an immense amount of threading is rejected. It will be seen, upon a little reflection, that this groove could not possibly produce a leak unless it ran the entire length of the thread contact, and in depth went below the bottom of the thread.

Broken Threads.*

Another cause of rejection of material is where the threads have been broken off a little. Propably not so much as one per cent of the whole bearing of the thread is gone, yet some wise (?) steamfitters will throw out this material. This is also an absurd theory, there being a large factor of strength in the length of all threads, as we know from the tests that we made some time ago with an eight inch coupling. We cut away all thread excepting three-eights of an inch, thereby leaving only about one-fifth of the ordinary bearing of that size thread, after which it was put under a pressure of one thousand pounds without a leak.

It is no doupt the common practice of steamfitters and engineers to reject threads were only one per cent are broken. The utter absurdity of this is shown by the above test, wherein about eighty per cent of the strength of the thread has been taken away.

For the purpose of illustrating these erroneous ideas, we took an eight-inch coupling and a piece of eight-inch pipe, and throughout the whole length of the bearing of the thread in the coupling and on the pipe we made grooves, such as are likely to occure when there is a defective weld. The grooves extented about half the depth of the thread, and were made an inch apart for the entire circumference of the pipe. Then we flattened all the threads, both on the pipe and in the coupling. excepting a mere speck in each. Also, to offset the broken thread feature of this question, we cut three grooves in the pipe, one-fourth of an inch wide and the full dept of the thread.

This coupling and piece of pipe were then screwed together and tested to 500 pounds of air, at which pressure the joint was tight, demonstrating conclusively the stupidity of steam-fitters and engineers on this subject, as claimed in the beginning of this article. The amount of defect in the threads used in this test was at least 100 per cent greater than that for which the regular steam-fitter or engineer will reject material.

Bursting Strength.*

Ordinary commercial pipe, 12″ and smaller, appears to have an ultimate bursting strength in excess of 1500 pounds per square inch, provided the weld is perfect. We have tested some lengths of 10″ pipe taken at random out of stock to 2,300 pounds per square inch; 8″ pipe to 2,000 pounds; 12″ to 1500 pounds; 16″ ⅜″ thick to 800 pounds; 24″ ⅜″ thick to 600 pounds—all without rupture or apparent distortion, We have tested from time to time thousands of pieces of all sizes, 20″ and smaller. under 800 pounds per square inch, so that as far as strength is concerned, there appears to be no reason why pipe heavier than standard should be used on power plant work. In plants where the feed water is bad, it is economy to run the feed lines of extra strong pipe, and this has become quite a common practice even where the water is comparatively good.

Size of Drills and Taps for Wrought Iron Pipe.

Internal Dia. Inches	Size of Drill	No. Thrds Pr. Inch	Length of Perfect Thrd at Bottom
$\frac{1}{8}$	.3281=$\frac{21}{64}$	27	$\frac{3}{16}$
$\frac{1}{4}$	.4531=$\frac{29}{64}$	18	$\frac{9}{32}$
$\frac{3}{8}$	.5937=$\frac{19}{32}$	18	$\frac{19}{64}$
$\frac{1}{2}$	.7187=$\frac{23}{32}$	14	$\frac{3}{8}$
$\frac{3}{4}$	.9375=$\frac{15}{16}$	14	$\frac{13}{32}$
1	1.1857=$1\frac{3}{16}$	$11\frac{1}{2}$	$\frac{1}{2}$
$1\frac{1}{4}$	1.4687=$1\frac{15}{32}$	$11\frac{1}{2}$	$\frac{35}{64}$
$1\frac{1}{2}$	1.7187=$1\frac{23}{32}$	$11\frac{1}{2}$	$\frac{9}{16}$
2	2.1875=$2\frac{3}{16}$	$11\frac{1}{2}$	$\frac{37}{64}$
$2\frac{1}{2}$	2.6875=$2\frac{11}{16}$	8	$\frac{7}{8}$
3	3.3125=$3\frac{5}{16}$	8	$\frac{15}{16}$
$3\frac{1}{2}$	3.8125=$3\frac{13}{16}$	8	1
4	4.3125=$3\frac{5}{16}$	8	$1\frac{3}{64}$
$4\frac{1}{2}$	$4\frac{13}{16}$	8	$1\frac{7}{64}$
5	$5\frac{3}{8}$	8	$1\frac{5}{32}$
6	$6\frac{3}{8}$	8	$1\frac{1}{4}$
7	$7\frac{7}{16}$	8	$1\frac{3}{8}$
8	$8\frac{7}{16}$	8	$1\frac{7}{16}$
9		8	$1\frac{9}{16}$
10	$10\frac{15}{32}$	8	$1\frac{11}{16}$
12		8	

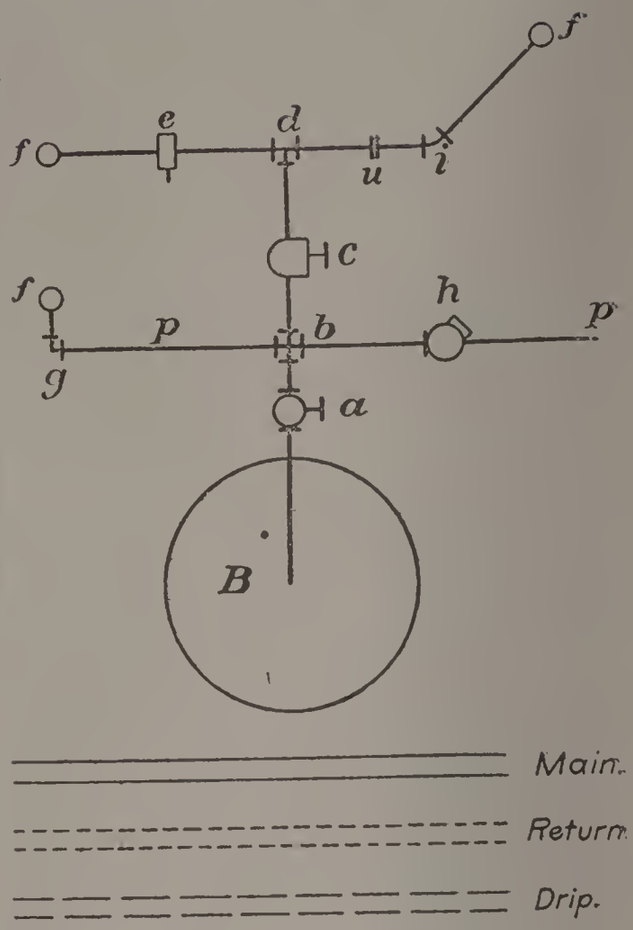
Threads taper $\frac{3}{4}$" in one foot

Capacity of Pipe.

Capacities and Threads of Standard W. I. Pipe

Nominal Inside Diam. Inches	Length to Thread Inches	Length of Pipe Containing one Gallon Feet	Contained Pounds of Water per Lineal Foot	Nominal Inside Diam. Inches	Length to Thread Inches	Length of Pipe Containing one Gallon Feet	Contained Pounds of Water per Lineal Foot
⅛	¾	336.6	.024	3½	1⅝	1.95	4.285
¼	⅝	148.8	.044	4	1⅝	1.51	5.517
⅜	⅞	100.8	.082	4½	1¼	1.2	6.908
½	½	63.2	132	5	1¼	96	8.668
¾	½	36.1	23	6	1⅜	.66	12.521
1	⅝	22.3	.373	7	1½	.49	16.79
1¼	1	12.8	.648	8	1⅝	.38	21.688
1½	1	9.4	.883	9	1⅝	3	27.58
2	⅞	5.7	1.454	10	1¾	.24	34.171
2½	1	4.02	2.072	11		.2	41.189
3	1	2.6	3.202	12		.17	49.017

Conventional Pipe Fittings.



The above illustration shows a maner of drawing in pipe, fittings and valves in a conventional method.

There are many cases where such a drawing will be quite suitable to the needs of the steamfitter who will have to cut and put up the pipe to the requirements.

Illustration from Machinery.

Pipe is made in lengths varying from 16 to 20 feet and is threaded unless otherwise ordered.

NATIONAL TUBE CO.—Black or Galvanized Standard Weight Pipe.

Diameter.			Thick-ness.	Circumference.		Transverse Areas.			Nom. Wgt. per ft. lbs.	Threads per In.
Nom.	External.	Internal.		External.	Internal.	External.	Internal.	Metal.		
⅛	.405	.269	.068	1.272	.845	.1288	.0568	.0720	.241	27
¼	.540	.364	.088	1.696	1.144	.2290	.1041	.1249	.42	18
⅜	.675	.493	.091	2.121	1.549	.3578	.1909	.1669	.559	18
½	.840	.622	.109	2.639	1.954	.5542	.3039	.2503	.837	14
¾	1.050	.824	.113	3.299	2.589	.8659	.5333	.3326	1.115	14
1	1.315	1.047	.134	4.131	3.289	1.3581	.8609	.4972	1.668	11½
1¼	1.660	1.380	.140	5.215	4.335	2.1642	1.4957	.6685	2.244	11½
1½	1.900	1.610	.145	5.969	5.058	2.8353	2.0358	.7995	2.678	11½
2	2.375	2.067	.154	7.461	6.494	4.4301	3.3556	1.074	3.609	11½
2½	2.875	2.467	.204	9.032	7.750	6.4918	4.7800	1.712	5.739	8
3	3.500	3.066	.217	10.996	9.632	9.6211	7.3827	2.238	7.536	"
3½	4.000	3.548	.226	12.566	11.146	12.566	9 886	2.680	9.001	"
4	4.500	4.026	.237	14.137	12.648	15.904	12.730	3.174	10.665	"
4½	5.000	4.508	.246	15.708	14.162	19.635	15.960	3.675	12.34	"
5	5.563	5.045	.259	17.477	15.849	24.306	19.985	4.321	14.502	"
6	6.625	6.065	.280	20.813	19.054	34.472	28.886	5.586	18.762	"
7	7.625	7.023	.301	23.955	22.063	45.664	38.743	6.921	23.271	"
8	8.625	7.981	.322	27.096	25.073	58.426	50.021	8.405	28.177	"
9	9.625	8.937	.344	30.238	28.076	72.760	62.722	10.04	33.701	"
10	10.750	10.018	.366	33.772	31.472	90.763	78.822	11.94	40.065	"
11	11.750	11.000	.375	36.913	34.558	108.43	95.034	13.40	45.95	"
12	12 750	12.000	.375	40.055	37.699	127.68	113.09	14.59	48.985	"

Allow variation in weight per foot of 5 per cent. above and 5 per cent. below. Cannot cut closer to length than ½ inch. Shipped threads and couplings unless otherwise ordered.

NATIONAL TUBE CO.—Standard Extra Strong Pipe.

Diameter			Thick-ness.	Circumference.		Transverse Areas.			Nom. Wgt. per ft. lbs.	Threads per In.
Nom.	External.	Internal.		External.	Internal.	External.	Internal.	Metal.		
⅛	.405	.205	.100	1.272	.644	.129	.033	.096	.29	27
¼	.540	.294	.123	1.696	.924	.229	.068	.161	.54	18
⅜	.675	.421	.127	2.121	1.323	.358	.139	.219	.74	18
½	.840	.542	.149	2.639	1.703	.554	.231	.323	1.09	14
¾	1.050	.736	.157	3.299	2.312	.866	.425	.441	1.39	14
1	1.315	.951	.182	4.131	2.988	1.358	.710	.648	2.17	11½
1¼	1.660	1.272	.194	5.215	3.996	2.164	1.271	.893	3.00	11½
1½	1.900	1.494	.203	5.969	4.694	2.835	1.753	1.082	3.63	11½
2	2.375	1.933	.221	7.461	6.073	4.430	2.935	1.495	5.02	11½
2½	2.875	2 315	.280	9.032	7.973	6.492	4.209	2.283	7.67	8
3	3.500	2.892	.304	10.996	9.086	9.621	6.569	3.052	10.25	"
3½	4.000	3.358	.321	12.566	10.549	12.566	8.856	3.710	12.47	"
4	4.500	3.818	.341	14.137	11.995	15.904	11.449	4.455	14.97	"
4½	5.000	4.280	.360	15.708	13.446	19.635	14.387	5.248	18.22	"
5	5.563	4.813	.375	17.477	15.120	24.306	18.193	6.113	20.54	"
6	6.625	5.751	.437	20.813	18.067	34.472	25.976	8.496	28.58	"
7	7.625	6.625	.500	23.955	20.813	45.664	34.472	11.192	37.67	"
8	8.625	7.625	.500	27.096	23.955	58.426	45.664	12.762	43.00	"
9	9.625	8.625	.500	30.238	27.096	72.760	58.426	14.334	48.25	"
10	10.750	9.750	.500	33.772	30.631	90.763	74.662	16.101	54.25	"
12	12.750	11.750	.500	40.055	36.914	127.68	108.43	19.25	65.00	"

NATIONAL TUBE CO.—Standard Double Extra Strong Pipe.

Diameter.			Thick-ness.	Circumference.		Transverse Areas.			Nom. Wgt. per ft. lbs.	Threads per In.
Nom.	External.	Internal.		External.	Internal.	External.	Internal.	Metal Area		
½	.840	.244	.298	2.639	.767	.554	.047	.507	1.7	14
¾	1.050	.422	.314	3.299	1.326	.866	.140	.726	2.44	14
1	1.315	.587	.364	4.131	1.844	1.358	.271	1 087	3.65	11½
1¼	1.660	.885	.388	5.215	2 780	2.164	.615	1.549	5.2	11½
1½	1.900	1.088	.406	5.969	3.418	2.835	930	1.905	6.4	11½
2	2.375	1.491	.442	7 461	4.684	4.430	1.744	2.686	9.02	11½
2½	2.875	1.755	.560	9 032	5.514	6.492	2.419	4.073	13.68	8
3	3.500	2.284	.608	10 996	7.176	9.621	4.097	5.524	18.56	"
3½	4.000	2.716	.642	12.566	8.533	12.566	5.794	6.772	22.75	"
4	4.500	3.136	.682	14.137	9.852	15.904	7.724	8.180	27.48	"
4½	5.000	3.564	.718	15 708	11.197	19.635	9.976	9.659	32.53	"
5	5.563	4.063	750	17.477	12 764	24.306	12.965	11.341	38.12	"
6	6.625	4.875	.875	20.813	15.315	34.472	18.665	15.807	53.11	"
7	7.625	5.875	.875	23.955	18 457	45.664	27.109	18.555	62.38	"
8	8.625	6.875	.875	27.096	21.598	58.426	37.122	21.304	71.62	"

Expansion of Pipe.

The expansion of pipe on being heated must always be considered in the arrangement of steam piping of any kind.

If a long pipe ends at a corner or in other words, the steam is to be taken around a turn, this corner often affords opportunity to the pipe to stretch some without straining joints or breaking fittings.

Expansion of Wrought Iron Pipe

Temperature of the Air when Pipe is fitted	Length of Pipe when fitted	Length of Pipe when heated to							
		215°		265°		297°		338°	
		Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.
Zero	100 feet	100	1.72	100	2.12	100	2.31	100	2.70
32°	100 "	100	1.47	100	1 78	100	2.12	100	2.45
64°	100 "	100	1.21	100	1.61	100	1.87	100	2.19

Pipe expands about 1″ in 125′ on a rise of temperature of 100° or 2¼ in 100″ for a rise from 64° to 344° which is the temperature of steam at 125 lbs. preassure. A cast iron pipe 254 feet long has been known to expand 7′. (It has been stated in "*Heating and Ventilation*" that a pipe might be considered to move about 1⅜″ in 100 feet in a change of temperature from 30 to 212° or about 1-900 of its length.)

Pipe should not be supported on a brick or a flat piece of iron when laid in a box underground, for it has been found that the movement of the pipe due to expansion has worn a hole in the pipe.

Some simple roller arrangement should be put under the pipe to carry it while expanding.

Hanging Pipe.

Pipe must be supported at intervals to keep it in line and to avoid strain on the joints.

When near a wall, the pipe may be supported by means of brackets, but it should be far enough out to permit covering unless the surface is to be used as a radiator.

When the pipe is of large diameters and of some considerable length, supports may be designed to carry it the distance between their centers should not be over 15 feet.

Pipe should never be hung level. but given about ½′ in 10′ drop back to the boiler or steam supply. This allows for drainage of liquids, except a small amount that always collects at the recess in the fittings and in some cases this is carried off by means of a small cock.

Covering Pipe.

The radiating of heat from steam and hot water is a source of loss which enters greatly into the cost of operating a plant so that means must be employed to prevent it, and it is found that by covering the pipes with certain substances, a great saving is obtained.

Some special coverings are being used which affords a saving from 7 to 35% over bare pipe.

"Any suitable substance which is used to prevent the escape of steam heat should not be less than 1″ thick and should be kept dry, for not only is water a good carrier of heat. but it has been found that still water conducts heat about eight times as rapidly as still air.,.—*Kent.*

Bending of Wrought Iron Pipe.

To facilitate the flow of liquid and gases in pipes, the change in direction should be made as easy as possible so that long bends are commendable and the bending of pipe is resorted to instead of using elbows.

These bends save joints, save power in forcing the matter around the corners and are much more sightly. Standard wrought iron pipe can be bent readily to many shapes and withstand the effects of so doing without visible signs of weakening.

To make bends in small pipe, it is usually filled with dry sand and both ends capped, the sand aids in keeping the pipe circular in cross section. The pipe should be heated slowly and never more than cherry red and the bending done in an even and carefull manner to avoid buckling.

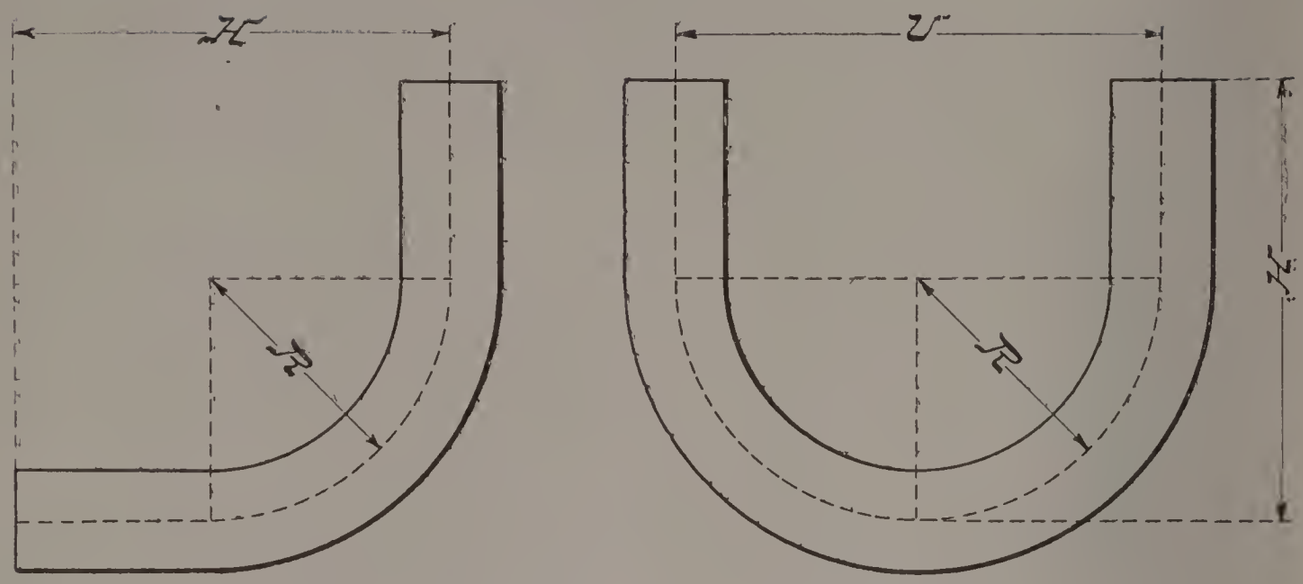
Bending blocks should be used if possible, having them arranged in holes in a large iron plate set two or three feet from the ground.

The pipe will have to be threaded on both ends to allow capping and in some cases, this would have to be done before bending, even if sand was not to be used.

The accompanying table will give an idea of the amount of radii used for various sizes of pipe.

MEMMORANDUM.

Wrought Iron Pipe Bends.



R=Radius, H=Center, U=Center to center.

STANDARD RADIUS.				MINIMUM RADIUS			STANDARD RADIUS'				MINIMUM RADIUS		
Size	R	H	U	R	H	U	Size	R	H	U	R	H	U
⅛	3″	3¾″	6″	1″	1¾″	2″	7	4′0″	4′7″	8′0″	2′6″	3′1″	5′0″
¼	3½	4½	7	1¼	2¼	2½	8	4 6	5 2	9 0	3 2	3 10	6 4
⅜	4	5¼	8	1½	2¾	3	10	5 6	6 6	11 0	4 4	5 4	8 8
½	5	6½	10	1¾	3¼	3½	12	7 6	8 8	15 0	6 6	7 8	13 0
¾	6	7¾	12	2	3¾	4	*	O. D.					
1	7	9¼	14	2¼	4½	4½	14	8 0	9 6	16 0	7 6	9 0	15 0
1¼	8	10½	16	2¾	5¼	5½	16	10 0	11 10	20 0	8 6	10 4	17 0
1½	10	12¾	20	3¼	6	6½	18	12 0	14 0	24 0	9 6	11 6	19 0
2	12	15	2 4	4½	7½	9	20	14 0	16 0	28 0	10 6	12 6	21 0
2½	14	17½	2 4	6	9½	12	22	16 0	18 0	32 0	11 6	13 6	23 0
3	18	22	3 0	7	11	14	24	18 0	20 0	36 0	12 6	14 6	25 0
3½	20	2 0½	3 4	9	13½	18							
4	24	2 5	4 0	12	17	24							
4½	2 2	2 7½	4 4	15	20½	2 6							
5	2 6	3 0	5 0	18	24	3 0							
6	3 0	3 6½	6 0	24	2 6½	4 0							

*O. D. 14 in. and larger is for lap weld steel pipe whose outside diam. is of sizes given.

BENDS below heavy line made in two pieces. Larger Radius to order,

S—Bends and special radius fittings to order.

NOTE—From "Standard Tables," Best Mfg. Co., Pittsburg, Pa.

Pipe Columns.

Columns of wrought iron pipes with a flange on each end are quite common but the pipe shall be screwed well into the flanges and should be of good material. Of course extra strong pipe answers best as seen from the table.

The formula for the safe load is as follows:—

$$\text{safe load} = \left\{ \frac{1}{1+\frac{\frac{10000}{L^2}}{36000^2}} \right\} \times A$$

where

A=area in square inches.

$r^2 = \frac{D^2+d^2}{16}$ = square of least radius of gyration.

D=outside diameter.

d=inside dianeter.

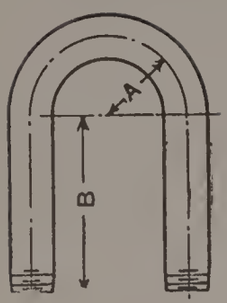
L=length in diameter.

STANDARD W. I. PIPE.

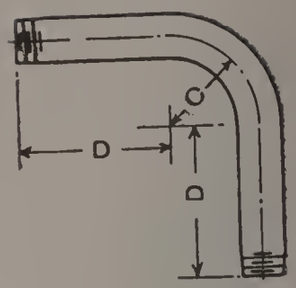
DIAMETER		AREA OF METAL	SAFE LOAD IN POUNDS			
Inside	Outside		6 Ft.	8 Ft.	10 Ft.	12 Ft.
2	2.372	1.07	10 300	9 000	7 700	6 500
2½	2.875	1.708	13 500	12 200	10 800	9 500
3	3.50	2.243	23 000	21 300	16 600	7 700
3½	4.00	2.678	27 300	25 800	24 100	22 300
4	4.50	3.174	31 300	29 900	28 300	26 600
5	5.563	4.316	44 700	43 300	41 800	40 000
6	6.635	5.584	59 600	58 400	56 800	55 000
7	7.625	6.926	67 300	66 200	64 900	63 400
8	8.725	8.386	82 400	82 400	81 300	79 700

EXTRA HEAVY W. I. PIPE.

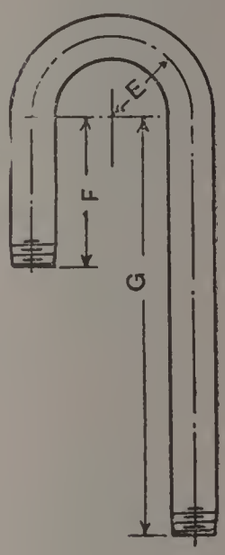
2	2.375	1.495	11 700	10 100	8 700	7 300
2½	2.875	2.283	19 200	17 200	15 200	13 300
3	3.50	3.052	27 500	25 500	23 400	21 200
3½	4.00	3.71	34 600	32 700	30 400	28 000
4	4.50	4.455	41 600	39 700	37 500	35 200
5	5.563	6.12	58 600	56 800	54 600	52 200
6	6.625	8.505	82 000	80 200	77 900	75 400



Bends and Goose Necks of Wt. Iron Pipe. Made of Extra Strong.



Size of Pipe	A	B	C	D	E	F
$\frac{3}{4}$					2	$3\frac{3}{4}$
1	$2\frac{1}{4}$	5	$2\frac{1}{2}$	$4\frac{1}{4}$	$2\frac{1}{4}$	$4\frac{1}{4}$
$1\frac{1}{4}$	3	6	$4\frac{3}{4}$	$6\frac{1}{2}$	3	6
$1\frac{1}{2}$	4	8	$6\frac{3}{4}$	$8\frac{1}{2}$		
2	4	8	$6\frac{3}{4}$	$9\frac{1}{2}$		



Wrought Iron Pipe Nipples.

Nipples are short pieces of standard pipe, threaded and kept in stock to facilitate matters when pipe work is to be done.

Where fittings or valves are to be very near each other, the threads of the intervening nipple run together and thus create the term of "close nipple", but if a small amount of bare surface of the pipe is exposed it is then called a "short nipple" and the table gives the lengths of these two classes with the addition of "long nipple".

As will be seen these very in length and are followed by the extra long which include all lenghths from "long" to 12", though it will be found that a large per cent of pipe fitters cut their own nipples when they are to be over 6" long.

Wrought iron nipples can be secured in length corresponding to the above table in sizes. including 4" pipe, with right hand threads on one end and left hand on the other.

Galvanized right hand nipples can be secured in sizes and lengths up to and including 6", the 7 and 8" sizes in "close" and "short" only.

"Short" nipples have the same meaning as "Should" nipples.

Right and left hand nipples with hexagon shoulders in the center, made of malleable iron, may be secured in sizes from $\frac{1}{4}$ to 2" inclusive and are therefore about the length of "short" nipples of various diameters.

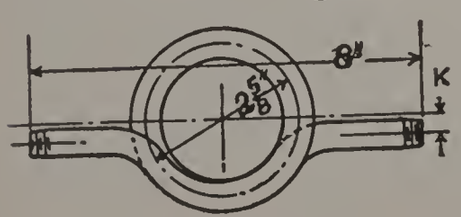
Nipples.

Pipe Size	LENGTH IN INCHES						
	Close	Short	Long				Extra Long
$\frac{1}{8}$	$\frac{3}{4}$	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3	$3\frac{1}{2}$	
$\frac{1}{4}$	$\frac{7}{8}$	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3	$3\frac{1}{2}$	
$\frac{3}{8}$	1	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3	$3\frac{1}{2}$	
$\frac{1}{2}$	$1\frac{1}{8}$	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3	$3\frac{1}{2}$	
$\frac{3}{4}$	$1\frac{3}{8}$	2	$2\frac{1}{2}$	3	$3\frac{1}{2}$	4	
1	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3	$3\frac{1}{2}$	4	
$1\frac{1}{4}$	$1\frac{5}{8}$	$2\frac{1}{2}$	3	$3\frac{1}{2}$	4	$4\frac{1}{2}$	
$1\frac{1}{2}$	$1\frac{3}{4}$	$2\frac{1}{2}$	3	$3\frac{1}{2}$	4	$4\frac{1}{2}$	Nipples can be obtained in all these pipe sizes in length up to and including 12 varying by inches.
2	2	$2\frac{1}{2}$	3	$3\frac{1}{2}$	4	$4\frac{1}{2}$	
$2\frac{1}{2}$	$2\frac{1}{2}$	3	$3\frac{1}{2}$	4	$4\frac{1}{2}$	5	
3	$2\frac{1}{2}$	3	$3\frac{1}{2}$	4	$4\frac{1}{2}$	5	
$3\frac{1}{2}$	$2\frac{3}{4}$	4	$4\frac{1}{2}$	5	$5\frac{1}{2}$	6	
4	3	4	$4\frac{1}{2}$	5	$5\frac{1}{2}$	6	
$4\frac{1}{2}$	3	4	5	$5\frac{1}{2}$	6	$6\frac{1}{2}$	
5	$3\frac{1}{4}$	$4\frac{1}{2}$	5	$5\frac{1}{2}$	6	$6\frac{1}{2}$	
6	$3\frac{1}{4}$	$4\frac{1}{2}$	5	$5\frac{1}{2}$	6	$6\frac{1}{2}$	
7	$3\frac{1}{2}$	5					
8	$3\frac{1}{2}$	5					
9	4	5					
10	4	5					
12	4	5					

SYPHONS—Made of Wrought Pipe.

A syphon is a bent piece of $\frac{1}{4}$" pipe as shown in Fig. 1.

It is placed between the boiler and the steam gage to catch some water and use it against the spring of the gage, instead of the steamdirect.



No steam gage should be placed in service without a syphon and a valve as shown in chapter on Miscellaneous Articles for gages and water columns,

K should be about $\frac{1}{2}$ inch.

Cast Iron Bell and Spigot Pipe.

DIA. INSIDE	FOR WATER. lbs. per foot	FOR WATER. lbs. per length	FOR GAS lbs. per foot	FOR GAS lbs. per length	Length including Bell.	Depth of Bell or Socket.	Joint room or Lead Space.	Hemp per joint lbs.	Lead per joint lbs.
1	2.8	17	2 8	17	6—4			.08	2.00
1¼	3.5	21	3 3	21	6—4			.09	2.25
1½	4.5	36	4 0	36	8—4			.10	2.75
2	6.7	60	6 0	60	9—4			.14	3.25
2½	8.0	72	8 0	72	9—4			.16	3.90
3	13.9	167	12 5	150	12—4	2½	1⅝	.18	4.4
3½	16.5	200			12—4	3½	"	.20	5.
4	19.2	230	18	216	12—4	4	"	.21	5.5
5	24.6	295			12—4	4	"	.27	6.8
6	30.4	364	28 5	342	12—4	4	"	.31	8.0
7	36.7	440			12—4	4	"	.37	9.8
8	42.8	513	40	480	12—4	4	"	.44	11.5
9	49.6	595			12—4	4	"	.48	13.0
10	57.1	685	5	660	12—4	4	"	.53	14.5
12	72.5	870	70	840	12—4	4	"	.61	18.0
14	89.5	1074	90	1080	12—4	4	"	.81	21.5
15	98.3	1180			12—4	4	"	.87	23.0
16	107.8	1293	110	1320	12—4	4	"	.94	24.0
18	127.7	1532	140	1680	12—4	4	"	1.00	27.0
20	149.0	1788	150	1800	12—4	4	"	1.25	31.5
24	200.6	2407	200	2400	12—4	4	"	1.50	37.0
30	290.2	3482	290	3480	12—4	4	"	2.06	51.0
36	391.6	4699	360	4320	12—4	4	1⅞	3.00	75.0
40	483.4	5807	420	5040	12—4	5	"	3.37	85.0
42	512.3	6147			12—4	5	"	3.62	90.0
48	665.2	7982	560	6720	12—4	5	"	4.37	110.0
60	916.7	11000			12—4	5	"	6.25	150.0
72	1257.5	15090			12—4	5	"	9.	220.0

NOTE:—The pressure of water per square inch is 21.65 lbs. for every 50 ft. head.
The weights given in the table are for pipe that carry a pressure of 43 lbs. or a head of 100 ft.

Flanged Pipe.—Gas, and Water Weight.

Size of Pipe	Thickness of Pipe	Diameter of Pipe	Thickness of Flange	Diameter of Bolt Circle	No. and Size of Holes	Size of Bolts	Length of Bolts	Estimated Weight Per Foot	Estimated Weight 12 Ft. Length
4	3/8	9	15/16	7 1/2	4— 7/8	3/4	2 3/4	17	204
6	7/16	11	1	9 1/2	8— 7/8	3/4	3	30	360
8	7/16	13 1/2	1 1/8	11 3/4	8— 7/8	3/4	3 1/2	40	480
10	7/16	16	1 3/16	14 1/4	12—1	7/8	3 5/8	50	600
12	1/2	19	1 1/4	17	12—1	7/8	3 3/4	70	840
14	9/16	21	1 3/8	18 3/4	12—1 1/8	1	4 1/4	83	1000
16	9/16	23 1/2	1 7/16	21 1/4	16—1 1/8	1	4 1/4	100	1200
18	11/16	25	1 9/16	22 3/4	16—1 1/4	1 1/8	4 3/4	133	1600
20	11/16	27 1/2	1 11/16	25	20—1 1/4	1 1/8	5	150	1800
24	3/4	32	1 7/8	29 1/2	20—1 3/8	1 1/4	5 1/2	183	2200
30	7/8	38 3/4	2 1/8	36	28—1 1/2	1 3/8	6 1/4	275	3300
36	1	45 3/4	2 3/8	42 3/4	32—1 1/2	1 3/8	6 1/4	392	4708
42	1	52 3/4	2 5/8	49 1/2	36—1 5/8	1 1/2	7 1/2	497	5962
48	1 1/4	59 1/2	2 3/8	56	44—1 5/8	1 1/2	7 3/4	698	8374

Size of Pipe	Thickness of Pipe	Diameter of Flange	Thickness of Flange	Diameter of Bolt Circle	No. and Size of Holes	Size of Bolts	Length of Bolts	Estimated Weight Per Foot	Estimated Weight 12 Ft. Length
4	7/16	9	15/16	7 1/2	4— 7/8	3/4	2 3/4	22	264
6	1/2	11	1	9 1/2	8— 7/8	3/4	3	33	396
8	9/16	13 1/2	1 1/8	11 3/4	8— 7/8	3/4	3 1/2	45	540
10	5/8	16	1 3/16	14 1/4	12—1	7/8	3 5/8	60	720
12	5/8	19	1 1/4	17	12—1	7/8	3 3/4	80	960
14	3/4	21	1 3/8	18 3/4	12—1 1/8	1	4 1/4	117	1400
16	3/4	23 1/2	1 7/16	21 1/4	16—1 1/8	1	4 1/4	125	1500
18	7/8	25	1 9/16	22 3/4	16—1 1/4	1 1/8	4 3/4	167	2000
20	15/16	27 1/2	1 11/16	25	20—1 1/4	1 1/8	5	200	2400
24	1	32	1 7/8	29 1/2	20—1 3/8	1 1/4	5 1/2	250	3000
30	1 1/8	38 3/4	2 1/8	36	28—1 1/2	1 3/8	6 1/4	350	4200
36	1 3/8	45 3/4	2 3/8	42 3/4	32—1 1/2	1 3/8	6 1/4	475	5700
42	1 3/8	52 3/4	2 5/8	49 1/2	36—1 5/8	1 1/2	7 1/2	600	7200
48	1 1/2	59 1/2	2 3/4	56	44—1 5/8	1 1/2	7 3/4	775	9300

Flanged Pipe,—Heavy Weight.

Size of Pipe	Thickness of Pipe	Diameter of Flange	Thickness of Flange	Diameter of Bolt Circle	No. and Size of Holes	Size of Bolts	Length of Bolts	Estimated Weight Per Foot	Estimated Weight 12 Ft. Length
4	$\frac{1}{2}$	9	$\frac{15}{16}$	$7\frac{1}{2}$	4— $\frac{3}{4}$	$\frac{3}{4}$	$2\frac{3}{4}$	24	285
6	$\frac{9}{16}$	11	1	$9\frac{1}{2}$	8— $\frac{3}{4}$	$\frac{3}{4}$	3	39	465
8	$\frac{5}{8}$	$13\frac{1}{2}$	$1\frac{1}{16}$	$11\frac{3}{4}$	8— $\frac{3}{4}$	$\frac{3}{4}$	$3\frac{1}{2}$	57	680
10	$\frac{13}{16}$	16	$1\frac{3}{16}$	$14\frac{1}{4}$	12— 1	$\frac{7}{8}$	$3\frac{5}{8}$	84	1010
12	$\frac{13}{16}$	19	$1\frac{1}{4}$	17	12—1	$\frac{7}{8}$	$3\frac{3}{4}$	109	1304
14	$\frac{7}{8}$	21	$1\frac{3}{8}$	$18\frac{3}{4}$	12—$1\frac{1}{8}$	1	$4\frac{1}{4}$	137	1642
16	1	$23\frac{1}{2}$	$1\frac{7}{16}$	$21\frac{1}{4}$	16—$1\frac{1}{8}$	1	$4\frac{1}{4}$	178	2137
18	$1\frac{1}{16}$	25	$1\frac{9}{16}$	$22\frac{3}{4}$	16—$1\frac{1}{4}$	$1\frac{1}{8}$	$4\frac{3}{4}$	209	2503
20	$1\frac{1}{8}$	$27\frac{1}{2}$	$1\frac{11}{16}$	25	20—$1\frac{1}{4}$	$1\frac{1}{8}$	5	250	2980
24	$1\frac{1}{4}$	32	$1\frac{7}{8}$	$29\frac{1}{2}$	20—$1\frac{3}{8}$	$1\frac{1}{4}$	$5\frac{1}{2}$	330	3965
30	$1\frac{1}{2}$	$38\frac{3}{4}$	$2\frac{1}{8}$	36	28—$1\frac{1}{2}$	$1\frac{3}{8}$	$6\frac{1}{4}$	495	5937
36	$1\frac{3}{4}$	$45\frac{3}{4}$	$2\frac{3}{8}$	$42\frac{3}{4}$	32—$1\frac{1}{2}$	$1\frac{3}{8}$	$6\frac{1}{4}$	693	8316
42	2	$52\frac{3}{4}$	$2\frac{5}{8}$	$49\frac{1}{2}$	36—$1\frac{5}{8}$	$1\frac{1}{2}$	$7\frac{1}{2}$	924	11081
48	$2\frac{1}{4}$	$59\frac{1}{2}$	$2\frac{3}{4}$	56	44—$1\frac{5}{8}$	$1\frac{1}{2}$	$7\frac{3}{4}$	1182	14179

FOR YOUR NOTE.

Mr. John B. Root, who some 25 years ago, invented what is known as "spiral riveted pipe", either did not know or did not care that he misnamed his invention.

Probably, in common with many other mechanical men, he cared more for the thing than the name, or he would not have baptized his "spiral", when it is "helical" riveted, nor would he have been willing to stand sponsor for a spiral riveted pipe in the proper meaning of the term that would have meant a cone-shaped pipe with a spiral seam winding around it, and it would have puzzled even the most cheereful inventor to have invented a useful purpose for such a pipe. What he did invent was the pipe shown in Fig. 1, an article which has demonstrated its usefulness through the past 25 years, and for which new fields of usefulness are constantly being formed.

The strength of such a helical seam is even greater than would be supposed at first sight, if we look into it analyticaly. For example, take a pipe with an angle of the helix of 75° (the angle changes somewhat for the different diameters), we find the ratio of strenght, R. of such a seam to that of a straight seam similarly riveted by this rule.

$$R = \frac{2}{\sqrt{[(\text{consine of angle of inclination seam})^2 \times 3 + 1]}}$$

Then, the consine of angle 75° = .25882 and

$.25882 \times .25882 \times 3 + 1 = 1.2009633.$

And

$$\sqrt{1.2009633} = 1.96$$

Then $2 \div 1.096 = 1.82$

Showing that the helical seam of this angle is 82 per cent stronger than a similar seam placed longitudinally. Without stopping to figure out the "efficiency" of joint is possible with a single riveted longitudinal lap seam. we know that nothing better than 60 per cent, to 65 per cent can be expected. at the very best. We have, therefore, proved that with this style of seam the full strenght of the plate and even more is developed. This deduction is also borne out by tests made on the pipe, which tests when carried to the bursting point. have shown the point of fracture to be always in the center of the strip of metal of which the pipe is formed.

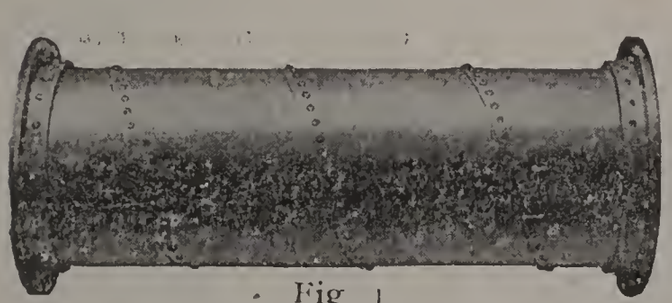


Fig 1

The pipe is made in lengths up to 25', and is furnished plain black, asphalted, single galvanized or double galvanized (which means the pipe is made of galvanized iron and regalvanized after the formation), all in accordance with the use for which it is intend, and is provided with riveted flange, bolted joints, sleeves or crimped ends, as required.

MATERIAL.—This has to be selected especially with a view to its welding and punching qualities, and for this the highest grade of wrought iron—rolled especially for this purpose, or cold rolled steel in long strips or coils is now used almost exclusively. While the cheaper grades of steel can be used. they cannot be made to weld as readily as the better grades, and for this reason should not be used.

WELDING.—This consists of joining together, on gas welding machines of special construction, strips from 8″ to 18″ wide, slitted from commercial sizes of plates. Two such strips are placed end to end in the weld-machine, with a lap of about ⅛″, and a pair of traveling top and bottom fire boxes, through which a powerful "blow-pipe" gas flame is made to impinge directly on the lap, are start-moving forth and back over the lap, untill a welding heat is reached; a pair of hammers, following immediately after the fireboxes, make the weld with a succession of rapid blows. The machine acts very rapidly, a weld 12″ long being made on an average in three minuets.

"SPIRAL" PIPE DATA.

Diameter of Pipe. Inches.	Thickness of Material B. W. G.	Weight, including Flanges, per foot, lbs.	Bursting Pressure per square inch, lbs.
3	No. 20	2¼	900
4	" 20	3	700
5	" 20	4	550
6	" 18	5	700
7	" 18	6	600
8	" 18	7	500
9	" 18	8	450
10	" 16	11	500
11	" 16	12	450
12	" 16	14	400
13	" 16	15	380
14	" 14	20	470
15	" 14	22	450
16	" 14	24	400
18	" 14	29	370
20	" 14	34	325
22	" 12	40	365
24	" 12	50	335

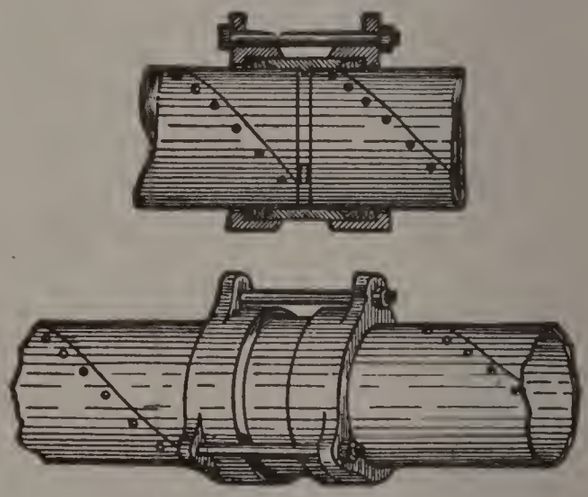


Fig. 2. Flange Joints.

Reels of upward of 1,000 feet in length are welded together in this fashion, and are then ready for the pipe-making machines.

Where double galvanized pipe is called for, these coils or reels are first "pickled" in a sulphuric acid bath and run through a galvanizing tank before being used in the pipe machines.

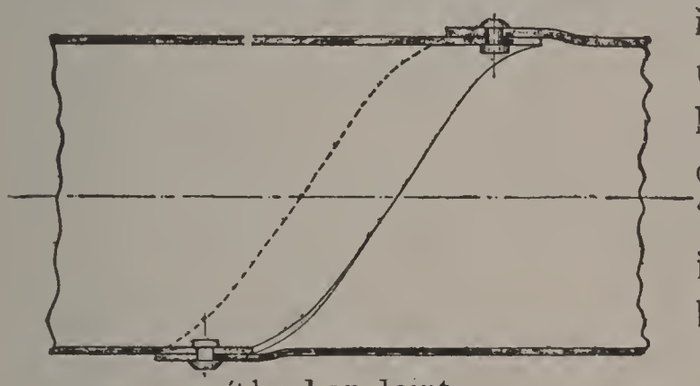
PIPE MAKING MACHINES.—These are semi-automatic in their action, the feeding, rolling, punching and riveting being all done automatically by the machine, the feeding of the rivets alone being left to the operator. An experienced operator on one of these machines can easily feed 45 to 50 rivets per minute and can make from 200 to 500 feet of pipe per day, depending upon the diameters. The machines are either made for one size only or are adjustable for several sizes of pipe. They are provided with means for varying the angle of the helix, as well as the

pitch of the rivets and the amount of lap, and are provided with a cutting off saw for cutting pipes to proper lenghts.

Flanging, Coating and Testing.

After being cut to sizes, the pipe is ready for the inspector's hands from where it is passed on to the flanging department, where flanges, if such are called for are attached to the ends of the pipe and the joint between pipe and flange made tight by peening.

From the flanging department the now practically finished pipe is passed into the galvanizing or asphalting department, where it receives its coating and is thereupon tested under hydrostatic pressure to 150 lbs. per square inch. Almost without an exception it is found to be "drop tight" at this pressure, or, if not absolutely tight, is made so before shipping.



The Lap Joint.

STANDARD DIMENSIONS OF COUPLINGS

FOR

STEAM, GAS AND WATER PIPE,

BLACK AND GALVANIZED.

Size of Pipe. Nominal Inside Diameter	Inside Diameter of Coupling	Outside Diameter of Coupling	Length of Coupling	Thread per Inch of Screw.	Average Weight of Coupling in Pounds.
Inches.	Inches.	Inches.	Inches.		
⅛	11/32	19/32	1/2	27	.031
¼	7/16	23/32	1/2	18	.046
⅜	27/64	27/32	1 1/16	18	.078
½	23/32	1	1 5/16	14	.124
¾	29/32	1 21/64	1 1/16	14	.250
1	1 11/32	1 9/16	1 13/16	11½	.455
1¼	1½	1 61/64	2⅛	11½	.562
1½	1¾	2 7/32	2⅜	11½	.800
2	2 7/32	2¾	2⅝	11½	1 350
2½	2 31/32	3 9/32	2⅞	8	1.757
3	3¼	3 15/16	3⅛	8	2 625
3½	3 25/32	4 7/16	3⅝	8	4.000
4	4 17/64	5	3⅝	8	4.125
4½	4¾	5½	3⅝	8	4.875
5	5 9/32	6 7/32	4⅛	8	8.437
6	6 11/32	7 5/16	4⅛	8	10.625
7	7⅜	8 5/16	4⅛	8	11.270
8	8⅜	9 5/16	4⅜	8	15.150
9	9 7/16	10⅜	5⅛	8	17.820
10	10 7/16	11 31/32	6⅛	8	27.700
11	11 15/32	12 31/32	6⅛	8	33.250
12	12 7/16	13⅞	6⅛	8	43.187
13	13 11/16	15 1/16	6⅛	8	49.280
14	14 29/32	16⅜	6⅛	8	63.270
15	15 11/16	17⅜	6⅛	8	66 000

Couplings.



Made of wrought iron, and usually sent with pipe when purchased in regular lengths. They are threaded right hand but can be obtained right and left if desired.

Lead Pipe,

LARGE SIZE OF LEAD PIPE.

SCALE OF WEIGHT

Caliber and Mark	Wt. per ft. lbs.	Wt. per ft. oz.	Caliber and Mark.	Wt. per ft. lbs.	Wt. per ft. oz.
2½ inch, ⅜ thick	16	11	3½ inch, ⅜ think	22	8
2½ " 5/16 "	13	10	3½ " 5/16 "	18	7
2½ " ¼ "	10	10	3½ " ¼ "	14	8
2½ " 3/16 "	7	13	3½ " 3/16 "	10	12
2½ " Waste	6	0	4 " ⅜ "	25	6
2½ " "	4	0	4 " 5/16 "	20	14
3 " ⅜ thick	19	9	4 " ¼ "	16	7
3 " 5/16 "	16	0	4 " 3/16 ,,	12	2
3 " ¼ "	12	9	4 " Waste	8	0
3 " 3/16 "	9	4	4 " "	6	0
3 " Waste	5	0	4 " "	5	0
3 " "	3	8			

PURE BLOCK TIN PIPE.

SCALE OF WEIGHTS.

Caliber	Weight per foot.		
⅛ inch.	.....	..... 3 oz.	.....
¼ "	.....	..... 5 "	.....
5/16 "	.....	..... 6½ "	.....
⅜ "	4½ oz.	..... 5 "	... 8 oz....
½ "	.....	..... 6½ "	... 10 " ...
⅝ "	.....	..... 9 "	... 14 " ...
¾ "	.....	..... 11 "	...1 lbs. ...
1 "	.....	..... 14 "	...1 " 4 " ...
1¼ "	.....	.....	...1 " 8 " ...

TIN-LINED LEAD PIPE.

Weight and Sizes same as Lead Pipe.

Lead, as a material for making pipe has been known for thousands of years. The Romans made lead pipe in short lengths from sheet lead with soldered seams before the Christian era, and used it for conducting water in places where their earthen pipes would not stand but it is only in recent years that the hydraulic press has been used by means of which the pipe is made in a very condensed state in a continious piece of almost any length, the only restriction being to coil and handle it.

Pipe made from pure lead is considered quite healthful and mixtures of other metals, such as zinc, antimony, tin, etc. are dangerous and objectionable.

It would probably be different to give the correct table of bursting pressures for the reason that it will vary with the quality of the lead. Lead produced in Missouri is very much harder and stronger then Desilviezed lead; and of course pipe made from it will stand a greater pressure.

Size	Letter	Thick-ness	Weight Per Foot	Size	Letter	Thick	Weight Per Foot
1/8		3/32	3 oz.	1″	E	3/32	1 1/2 lbs.
1/4	E	5/64	5 oz.	1	D	1/8	2 "
3/8	D	3/32	7 oz.	1	D	9/64	2 1/4 "
3/8	. . .	7/64	10 oz.	1	C	5/32	2 1/2 "
3/8	C	1/8	14 oz.	1	B	11/64	3 1/4 "
3/8	D	9/32	1 lb.	1	A	7/32	4 "
3/8	A	5/32	1 lb. 2 oz.	1	A A	15/64	4 1/2 "
3/8	A A	11/64	1 lb. 5 oz.	1	A A A	5/16	6 "
3/8	A A A	7/32	1 lb. 12 oz.	1 1/4	E	3/32	2 "
7/16	. . .	5/64	9 1/2 oz.	1 1/4	D	1/8	2 1/2 "
1/2	D	5/64	9 oz,	1 1/4	C	9/64	3 "
1/2	D	3/32	10 oz,	1 1/4	B	6/32	3 1/16 "
1/2	D	3/32	12 oz.	1 1/4	A	15/64	4 1/16 "
1/2	C	1/8	1 lb.	1 1/4	A A	1/4	5 3/4 "
1/2	B	1/8	1 lb. 3 oz.	1 1/4	A A A	19/64	6 3/4 "
1/2	A	5/32	1 lb. 10 oz.	1 1/2	E	3/32	2 "
1/2	A A	3/16	2 lbs.	1 1/2	D	7/64	3 "
1/2	. . .	7/32	2 lbs. 8 oz.	1 1/2	D	1/5	3 1/2 "
1/2	A A A	17/64	3 lbs.	1 1/2	C	5/32	4 1/4 "
5/8	E	3/32	12 oz.	1 1/2	B	7/32	5 "
5/8	D	7/64	1 lb.	1 1/2	A	13/64	6 1/4 "
5/8	D	1/8	1 lb. 4 oz,	1 1/2	A A	17/64	7 "
5/8	C	1/8	1 lb. 7 oz.	1 1/2	A A A	5/16	8 "
5/8	B	11/64	2 lbs.	1 3/4	D	1/8	3 5/8 "
5/8	A	13/64	2 lbs. 8 oz.	1 3/4	C	9/64	4 "
5/8	A A	7/32	2 lbs. 12 oz	1 3/4	B		5 "
5/8	A A A	17/64	3 lbs. 8 oz,	1 3/4	A		6 7/16 "
3/4	E	5/64	1 lb.	1 3/4	A A		8 1/2 "
3/4	D	3/32	1 lb. 3 oz.	2	Waste	7/64	3 "
3/4	C	9/64	1 lb. 12 oz.	2	D	1/8	4 "
3/4	B	5/32	2 lbs. 3 oz.	2	C	9/64	5 "
3/4	A	13/64	3 lbs.	2	B	6/32	6 "
3/4	A A	15/64	3 lbs. 8 oz.	2	A	13/64	7 "
3/4	. . .	1/4	4 lbs.	2	A A	1/4	8 7/8 "
3/4	A A A	9/32	4 lbs. 14 oz	2	A A A	5/16	10 11/16 "



Sewer Pipe.

The ordinary vitrified salt glazed sewer pipe is made in "Standard" and "Double" strength as shown in the following table.

Straight pipe is made in 2′ lengths from 3 to 8 inches and in $2\frac{1}{2}$ and 3 foot length for sizes of 8 to 36″ inclusive.

Increasers reducers, junctions and branches are made in 2″ lengths.

TABLE 1.—Discharge of Tile from 4 inches to 20 inches in diameter on a grade of 1 foot per 100 feet.

Diameter of Tile, in inches.	Discharge, in cubic feet, per second.	Diameter of Tile, in inches.	Discharge, in cubic feet, per second.	Diameter of Tile, in inches.	Discharge, in cubic feet, per second.
4	0.16	9	1.53	15	6.29
6	.49	10	2.05	18	10.37
8	1.11	12	3.40	20	13.85

TABLE 2.—Grades per 100 feet, and their square roots.

Grade, per 100 feet, in feet.	Grade, in inches, approximated	Square root of Grade	Grade, per 100 feet, in feet.	Grade, in inches, approximated.	Square root of Grade
0.04	½	0.200	0.40	4¾	0.632
.05	⅝	.224	.45	5⅜	.671
.06	¾	.245	.50	6	.707
.08	⅞	.283	.55	6⅝	.742
.09	1	.300	.60	7⅛	.775
.10	1⅛	.316	.65	7¾	.806
.12	1½	.346	.70	8⅜	.837
.14	1¾	.374	.75	9	.866
.16	2	.400	.80	9⅝	.894
.18	2¼	.424	.85	10¼	.922
.20	2½	.447	.90	10¾	.949
.25	3	.500	.95	11¼	.975
.30	3⅝	.548	1.00	12	1.000
.35	4¼	.592			

STANDARD PIPE.

Size of Pipe.	Depth of Sockets.	Thickness.	Annular Space	Weight. per foot.	Feet. per carload.
3 in.	1¾ in.	⅝ in.	¼ in.	8 lbs.	3,500
4 "	1¾ "	⅝ "	¼ "	9 "	2,500
5 "	1¾ "	¾ "	⅜ "	13 "	2,000
6 "	2 "	¾ "	⅜ "	16 "	1,600
7 "	2 "	¾ "	⅜ "	20 "	1,300
8 "	2½ "	13/16 "	⅜ "	23 "	1,000
9 "	2½ "	⅞ "	⅜ "	28 "	800
10 "	2½ "	15/16 "	⅜ "	34 "	700
12 "	3 "	15/16 "	½ "	38 "	550
14 "	3 "	1 1/16 "	½ "	53 "	480
15 "	3 "	1⅛ "	½ "	60 "	420
16 "	3 "	1 3/16 "	½ "	66 "	380
18 "	3 "	1¼ "	½ "	82 "	300
20 "	3 "	1⅜ "	½ "	105 "	250
21 "	3 "	1 7/16 "	½ "	.....	220
22 "	3 "	1 7/16 "	½ "	.....	200
24 "	3 "	1½ "	⅝ "	129 lbs.	160
27 "	4 "	.....	⅝ "	.....	110
30 "	5 "	.....	⅝ "	.....	100

Carrying Capacity of Sewer Pipe.

DOUBLE STRENGTH PIPE

Thickness.	Annular Space	Weight. per foot.	Feet. per carload
1 in.	½ in.	46 lbs.	540
1⅛ "	½ "	60 "	420
1¼ "	½ "	65 "	385
1⅜ "	½ "	75 "	330
1½ "	½ "	95 "	260
1 11/16 "	½ "	123 "	200
1¾ "	½ "	135 "	185
1⅞ "	½ "	140 "	180
2 "	⅝ "	175 "	140
2⅛ "	⅝ "	230 "	110
2¼ "	⅝ "	250 "	100

HARD-BURNED FARM DRAIN TILE.



Straight Tile
ONE FT



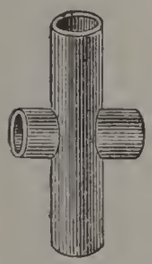
Straight Tile
TWO FT.



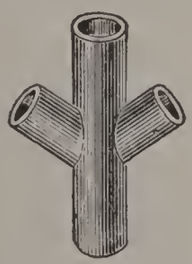
Y Junction



T Junction



TT Junction



YY Junction



Curve.



Reducer

Size.	Area in Inches	Weight per foot
3	7 07	5
4	12.57	7
5	19.63	9
6	28.27	11
7	38.48	14
8	50.27	18
9	63.72	25
10	78.54	29
12	113.09	34
14	153 93	48
15	176.71	50
16	201.06	60
18	254.46	67
20	314.16	94
21	346.36	100
22	380.13	110
24	452.39	112
27	572.55	185
30	706.85	218

CARRYING CAPACITY OF SEWER PIPE.

Gallons per Minute.

SIZES.	1" Fall in 100 Feet.	2" Fall in 100 Feet.	3" Fall in 100 Feet.	6" Fall in 100 Feet.	9" Fall in 100 Feet.	12" Fall in 100 Feet.	24" Fall in 100 Feet.	36" Fall in 100 Feet.
3	13	19	23	32	40	46	64	79
4	27	38	47	66	81	93	131	163
6	75	105	129	183	224	258	364	450
8	153	216	265	375	460	527	750	923
9	205	290	355	503	617	712	1006	1240
10	267	378	463	755	803	926	1310	1613
12	422	596	730	1033	1273	1468	2076	2554
15	740	1021	1282	1818	2224	2464	3617	4467
18	1168	1651	2022	2860	3508	4045	5704	7047
24	2396	3387	4155	5874	7202	8303	11744	14466
27	4407	6211	7674	10883	13257	15344	21771	26622
30	5906	8352	10223	14298	17714	20204	28129	35513
36	9707	13769	16816	23763	29284	33722	47523	58406

CHAPTER II.

FITTINGS.

By "Fittings" is meant such things as elbows, tees, crosses, branches, flanges, unions, reducers, bushings, caps, plugs, etc. ect., in fact everything except pipe and valves.

Fittings are made of wrought, malleable or cast iron and brass but dimensions for the latter will not be given here, although mention will be made of which ones may be obtained.

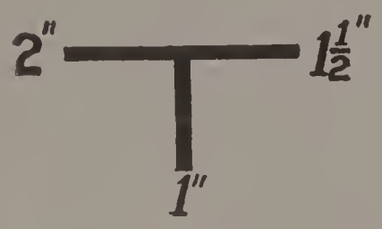
Couplings and flanges are the only ones made of wrought iron, malleable iron being used for fittings for gas, water and steam for medium pressures and cast iron being used for both screwed and flanged fittings for medium and heavy pressures.

Malleable fittings are made plain or beaded, the former for gas and low stream and water pressures,

The sizes of fittings refer to the pipe onto which they will screw or whose internal diameter corresponds closest to that of the fitting.

Straight fittings are those having all openings for the same size pipe. Reducing fittings may be obtained for many sizes made in both malleable and cast iron.

In describing tees, the run is named first, then the outlet and it would be written thus:



2" x 1½" x 1" and read a two by one and one-half by one inch tee.

The outlets of a cross are always the same size, are both denoted by the last figure. Thus 1¼ x 1 x 1 would indicate that one end was tapped for 1¼", the other end for 1" and the sides for 1".

The dimensions of the cross can be taken from the table for malleable tees and in the case of reducing on the side, take size necessary.

The same may be said of cast iron crosses whether screwed or flanged.

A "female" fitting is one with the threads inside, a "male", one with the threads on the outside.

MALLEABLE FITTINGS.

The malleable steam fittings are suitable to stand a working pressure of 150 pounds.

At various times and places, they have been tested to a hydraulic pressure of 2000 to 4000 pounds, without breakage.

It would seem that fittings which stand this test would be perfectly safe to stand 250 pounds working pressure. If proper care is exercised in using them, they will undoubtly answer every purpose for pressures up to 500 pounds, but as these as well as other fittings are subject to some risk of straining due to expansion, contraction or the making up of joints, manufacturers do not deem it proper to recommend them for the working pressure.

As goods made especially for extra heavy pressure are so very cheap, it does not seem to be a good business policy to use common fittings for the work.

To avoid making fittings to order. the use of bushings are recommended.

Where it is absolutely necessary tc have special fittings made, without the use of bushings, they can be had by sending specifications to the manufacturers. The price of same, in any event will be very high.

In ordering, always state whether fittings are to be used for steam, water, gas, or air.

The lists of malleable iron fittings shown in this book are manufactured and supplied to the trade.

There is such large variety of malleable elbows and tees reducing in the bore that dimensions cannot be given for all and perhaps it will be well to say that in case an end or side is to be reduced draw the fitting by the dimensions as given and build on the outlet to those for that size and make the pipes to size desired.

A few sizes are here given to show the manner in which dimensions change.

Elbows and tees with side outlets are made in the plain style only and are used almost exclusively for gas. Gas fittings are made with ears for screws also.

The illustrations here give a idea of some union tees and elbows which may be very convenient sometime.

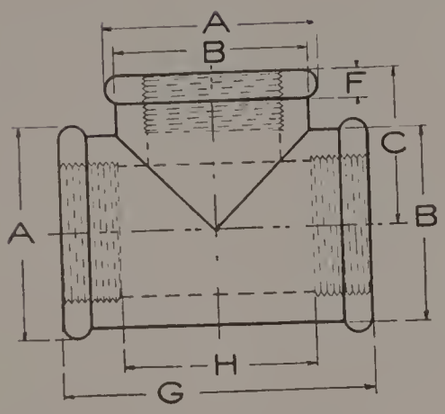
Malleable Union Elbows.



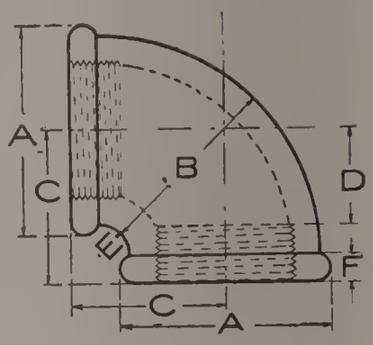
WITH FEMALE UNION



WITH MALE UNION



Malleable Elbows and Tees.



The dimensions for D and H are measured for the depth of thread but the pipe might not screw up to these figures.

Size	A	B	C	D	E	F	G	H
$\frac{1}{8}$	$\frac{5}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{8}$	$\frac{1}{16}$	$\frac{1}{8}$	$1\frac{1}{4}$	$\frac{3}{4}$
$\frac{1}{4}$	$\frac{7}{8}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{7}{16}$	$\frac{1}{16}$	$\frac{3}{16}$	$1\frac{9}{16}$	$\frac{3}{4}$
$\frac{3}{8}$	$1\frac{3}{16}$	$1\frac{1}{8}$	1	$\frac{1}{2}$	$\frac{1}{8}$	$\frac{1}{4}$	2	1
$\frac{1}{2}$	$1\frac{3}{8}$	$1\frac{1}{4}$	$1\frac{1}{16}$	$\frac{5}{8}$	$\frac{3}{16}$	$\frac{1}{4}$	2	$1\frac{1}{8}$
$\frac{3}{4}$	$1\frac{3}{4}$	$1\frac{3}{8}$	$1\frac{1}{4}$	$\frac{3}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$2\frac{1}{2}$	$1\frac{1}{4}$
1	$2\frac{1}{16}$	$1\frac{7}{8}$	$1\frac{3}{8}$	$\frac{7}{8}$	$\frac{5}{16}$	$\frac{1}{4}$	3	$1\frac{3}{4}$
$1\frac{1}{4}$	$2\frac{1}{2}$	$2\frac{1}{4}$	$1\frac{3}{4}$	$1\frac{1}{8}$	$\frac{5}{16}$	$\frac{3}{8}$	$3\frac{1}{2}$	$2\frac{1}{4}$
$1\frac{1}{2}$	$2\frac{3}{4}$	$2\frac{1}{2}$	2	$1\frac{1}{4}$	$\frac{3}{8}$	$\frac{3}{8}$	4	$2\frac{1}{2}$
2	$3\frac{3}{8}$	$2\frac{3}{4}$	$2\frac{1}{4}$	$1\frac{1}{2}$	$\frac{1}{2}$	$\frac{3}{8}$	$4\frac{1}{2}$	3
$2\frac{1}{2}$	4	$3\frac{1}{2}$	$2\frac{3}{4}$	$1\frac{3}{4}$	$\frac{9}{16}$	$\frac{7}{16}$	5	$3\frac{1}{4}$
3	5	$4\frac{1}{4}$	3	2	$\frac{5}{8}$	$\frac{1}{2}$	6	4
$3\frac{1}{2}$	$5\frac{3}{8}$	$4\frac{3}{4}$	$3\frac{1}{2}$	$2\frac{1}{2}$	$\frac{3}{4}$	$\frac{5}{8}$	7	$5\frac{1}{4}$
4	$6\frac{1}{4}$	$5\frac{1}{4}$	4	3	$\frac{3}{4}$	$\frac{5}{8}$	$7\frac{5}{8}$	$5\frac{1}{2}$
$4\frac{1}{2}$	$6\frac{1}{2}$	6	$4\frac{1}{2}$	$3\frac{1}{4}$	$\frac{3}{4}$	$\frac{5}{8}$	9	7
5	$7\frac{1}{8}$	$6\frac{1}{2}$	5	$3\frac{3}{4}$	$1\frac{1}{8}$	$\frac{5}{8}$	10	8
6	$8\frac{1}{8}$	$7\frac{1}{4}$	6	$4\frac{1}{2}$	$1\frac{1}{2}$	$\frac{5}{8}$	12	$9\frac{1}{2}$

"Service Tees" are made of malleable iron with one end threaded on the outside, like the street elbows, in sizes $\frac{1}{2}$" to $2\frac{1}{2}$" inclusive.

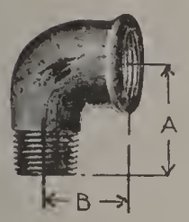
Malleable Street Elbows,

Elbows of 45° and 60° either plain or beaded and of 11¼° and 22½ beaded may be obtained in malleable iron in a few sizes. the latter two in 2½" only. The 45° style in sizes as the above table and the 60° in 1¼ 1½. 2 and 2" x 1½" only.

Galvanized maleable iron elbows may be obtained up to and including 4" and street elbows 2", 45° elbows

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Street Elbows.



Street elbows are made only in the beaded type. Malleable, in following sizes only a few being dimensioned here. Other dimensions the same as for beaded elbows.

Sizes ⅛, ⅜, ½, ¾ x ½, 1 x ¾, 1, 1¼ x 1, 1¼ x ¾, 1¼, 1½ x 1, 1½ x 1¼, 1½, 2 x 1, 2 x 1¼, 2 x 1½, 2, 2½, 2½ x2, 2½ x 1½, and 3.

The smaller size is on the Male end. Street elbows are made in sizes ½ to 2" inclusive. Street elbows are made in brass in several sizes.

Size	⅛	¼	⅜	½	¾	1	1¼	1½	2
A		$1\frac{3}{16}$	$1\frac{7}{16}$	$1\frac{5}{8}$	$2\frac{1}{4}$	$2\frac{3}{8}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$3\frac{1}{4}$
B		1	1	$1\frac{1}{16}$	$1\frac{5}{16}$	$1\frac{5}{8}$	$1\frac{7}{8}$	2	$2\frac{1}{2}$

Malleable Reducing Couplings.

Y==Branches.

These are similar to a tee with outlet set at an angle of 45° and 60° as desired. The former in sizes ½, ¾, 1, 1¼, 1½, 1½ x 1¼, 2, 2 x 1½ x 1½, 2 x 1¼, 2 x 1½, 2½, 2½ x 2, 3 3 x 2½, either plain or beaded. The 60° style is made in 1½, 2, 2 x 1½ sizes plain only. Double Y branches 45° and made beaded 1½" and plain and beaded 2".

Reducing Couplings.

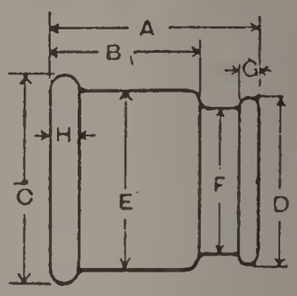
Table of size made.

Size.	
Plain	$\frac{1}{4}$ x $\frac{1}{8}$
Plain	$\frac{3}{8}$ x $\frac{1}{8}$
Beaded and Plain	$\frac{3}{8}$ x $\frac{1}{4}$
Plain	$\frac{1}{2}$ x $\frac{1}{4}$
Beaded and Plain	$\frac{1}{2}$ x $\frac{3}{8}$
Plain	$\frac{3}{4}$ x $\frac{1}{4}$
Plain	$\frac{3}{4}$ x $\frac{3}{8}$
Beaded and Plain	$\frac{3}{4}$ x $\frac{1}{2}$
Plain	1 x $\frac{1}{4}$
Plain	1 x $\frac{3}{8}$
Plain	1 x $\frac{1}{2}$
Beaded and Plain	1 x $\frac{3}{4}$
Beaded and Plain	$1\frac{1}{4}$ x $\frac{3}{8}$
Beaded and Plain	$1\frac{1}{4}$ x $\frac{1}{2}$
Beaded and Plain	$1\frac{1}{4}$ x $\frac{3}{4}$
Beaded and Plain	$1\frac{1}{4}$ x 1
Beaded and Plain	$1\frac{1}{2}$ x $\frac{3}{8}$
Beaded and Plain	$1\frac{1}{2}$ x $\frac{1}{2}$
Beaded and Plain	$1\frac{1}{2}$ x $\frac{3}{4}$
Beaded and Plain	$1\frac{1}{2}$ x 1
Beaded and Plain	$1\frac{1}{2}$ x $1\frac{1}{4}$

Size.	
Beaded and Plain	2 x $\frac{1}{2}$
Beaded and Plain	2 x $\frac{3}{4}$
Beaded and Plain	2 x 1
Beaded and Plain	2 x $1\frac{1}{4}$
Beaded and Plain	2 x $1\frac{1}{2}$
Beaded	$2\frac{1}{2}$ x 1
Beaded	$2\frac{1}{2}$ x $1\frac{1}{4}$
Beaded and Plain	$2\frac{1}{2}$ x $1\frac{1}{2}$
Beaded and Plain	$2\frac{1}{2}$ x 2
Beaded	3 x 1
Beaded	3 x $1\frac{1}{4}$
Beaded	3 x $1\frac{1}{2}$
Beaded and Plain	3 x 2
Beaded and Plain	3 x $2\frac{1}{2}$
Beaded	$3\frac{1}{2}$ x $2\frac{1}{2}$
Beaded	$3\frac{1}{2}$ x 3
Beaded	4 x 2
Beaded	4 x $2\frac{1}{2}$
Beaded	4 x 3
Beaded	4 x $3\frac{1}{2}$

Made in Malleable Iron and threaded right hand, either plain or beaded.





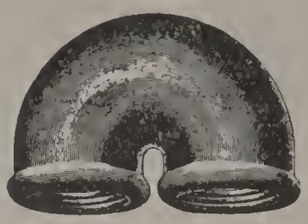
A FEW SIZES SHOWING MANNER OF REDUCTION.

Size	A	B	C	D	E	F	G	H
$\frac{1}{4} \times \frac{1}{8}$								
$\frac{3}{8} \times \frac{1}{4}$								
$\frac{3}{8} \times \frac{1}{8}$								
$\frac{1}{2} \times \frac{3}{8}$								
$\frac{1}{2} \times \frac{1}{4}$								
$\frac{1}{2} \times \frac{1}{8}$								
$\frac{3}{4} \times \frac{1}{2}$	$1\frac{9}{16}$	$1\frac{1}{8}$			$1\frac{3}{8}$	$1\frac{1}{8}$		
$\frac{3}{4} \times \frac{3}{8}$	$1\frac{9}{16}$	$1\frac{1}{8}$			$1\frac{3}{8}$	$\frac{7}{8}$		
1 $\times \frac{3}{4}$	$1\frac{7}{8}$	$1\frac{1}{8}$	$1\frac{7}{8}$	$1\frac{1}{2}$	$1\frac{11}{16}$	$1\frac{5}{16}$	$\frac{3}{16}$	$\frac{1}{4}$
1 $\times \frac{1}{2}$								
$1\frac{1}{4} \times 1$								
$1\frac{1}{4} \times \frac{3}{4}$								
$1\frac{1}{2} \times 1\frac{1}{4}$								
$1\frac{1}{2} \times 1$								
2 $\times 1\frac{1}{2}$	$2\frac{5}{8}$	2	$3\frac{1}{16}$	$2\frac{9}{16}$	$2\frac{3}{4}$	$2\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$
2 $\times 1\frac{1}{4}$								
2 $\times 1$								
$2\frac{1}{2} \times 2$								
$2\frac{1}{2} \times 1\frac{1}{2}$	$3\frac{1}{4}$	$2\frac{1}{2}$	$3\frac{1}{2}$	$2\frac{1}{2}$	$3\frac{5}{16}$	$2\frac{1}{4}$	$\frac{5}{16}$	$\frac{1}{4}$
3 $\times 2\frac{1}{2}$	$3\frac{1}{2}$	$2\frac{1}{2}$	$4\frac{1}{2}$	$3\frac{3}{4}$	$4\frac{1}{8}$	$3\frac{7}{16}$	$\frac{1}{4}$	$\frac{5}{16}$
3 $\times 2$								
4 $\times 3\frac{1}{2}$								

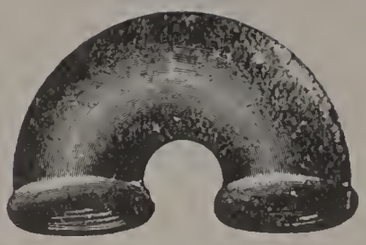
Return Bends—Malleable Iron.



Close



Medium



Open

Size Pipe	CENTER TO CENTER OF PIPES.							
	Close Patt.	Med. Patt	Open Patt.	Wide Patt.	Extra Heavy			
$\frac{3}{8}$				$1\frac{1}{2}$				
$\frac{1}{2}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$					
$\frac{3}{4}$	$1\frac{1}{4}$	$1\frac{1}{2}$	2	4				
$\frac{3}{4}$				6				
1	$1\frac{1}{2}$	$1\frac{7}{8}$	$2\frac{1}{2}$	6	$1\frac{3}{4}$			
1					$2\frac{1}{2}$			
$1\frac{1}{4}$	$1\frac{3}{4}$	$2\frac{1}{4}$	3	6				
$1\frac{1}{2}$	$2\frac{1}{4}$	$2\frac{1}{2}$	$3\frac{1}{2}$	6	5			
2	$2\frac{5}{8}$	3	4	5	3	$3\frac{1}{4}$	$3\frac{1}{2}$	$3\frac{3}{4}$
$2\frac{1}{2}$			$4\frac{1}{2}$					
3			5	$7\frac{1}{2}$				
3				8				
4				6				
6				12				

The close, medium and open are threaded either right, left or right and left hand and the wide pattern is threaded right hand only in its branches.

All sizes are made galvanized except extra heavy. Dimensions are about the same as for beaded malleable elbows.

CAPS,=PLUGS=BUSHINGS & NUTS.

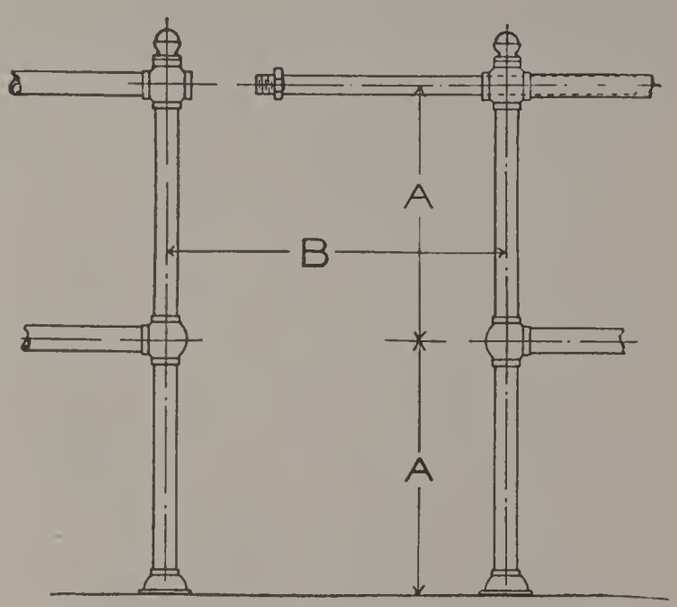
Size inside of caps and nut and outside plugs and bushings.	 CAP.				 PLUG.			 BUSHING			 NUT	
	Length	Dia. Body	" Beab	Bead	Length Thread	Length Nut	Side of Nut	Length Thread	Thick Nut	Across Flats of Nut.	Thick-ness Nut	Across Flats
$\frac{1}{8}$				none	$\frac{3}{8}$	$\frac{1}{4}$	$\frac{1}{4}$					
$\frac{1}{4}$				"	$\frac{7}{16}$	$\frac{1}{4}$	$\frac{3}{8}$				$\frac{1}{4}$	$\frac{7}{8}$
$\frac{3}{8}$				"	$\frac{1}{2}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{4}$	$\frac{3}{4}$	$\frac{5}{16}$	1
$\frac{1}{2}$	$\frac{7}{8}$	$1\frac{1}{16}$		"	$\frac{9}{16}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{15}{16}$	$\frac{3}{8}$	$1\frac{1}{4}$
$\frac{3}{4}$	$\frac{7}{8}$	$1\frac{1}{4}$	$1\frac{1}{2}$	$\frac{1}{8}$	$\frac{5}{8}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{1}{4}$	$1\frac{1}{8}$	$\frac{3}{8}$	$1\frac{1}{2}$
1				$\frac{1}{8}$	$\frac{3}{4}$	$\frac{7}{16}$	$\frac{11}{16}$	$\frac{1}{2}$	$\frac{3}{8}$	$1\frac{7}{16}$	$\frac{7}{16}$	$1\frac{7}{8}$
$1\frac{1}{4}$	$1\frac{1}{4}$	2	$2\frac{1}{4}$	$\frac{3}{16}$	$\frac{7}{8}$	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{8}$	$1\frac{3}{4}$	$\frac{1}{2}$	$2\frac{1}{8}$
$1\frac{1}{2}$	$1\frac{3}{8}$	2	$2\frac{1}{2}$	$\frac{1}{4}$	$\frac{7}{8}$	$\frac{1}{2}$	$\frac{13}{16}$	$\frac{13}{16}$	$\frac{3}{8}$	$1\frac{7}{8}$	$\frac{1}{2}$	$2\frac{3}{8}$
2	$1\frac{1}{2}$	$2\frac{3}{4}$	3	$\frac{1}{4}$	1	$\frac{9}{16}$	$1\frac{1}{16}$	$\frac{7}{8}$	$\frac{3}{8}$	$2\frac{3}{8}$	$\frac{1}{2}$	3
$2\frac{1}{2}$	$1\frac{5}{8}$	$3\frac{1}{4}$	$3\frac{1}{2}$	$\frac{1}{4}$	1	$\frac{5}{8}$	$1\frac{3}{16}$	$1\frac{15}{16}$	$\frac{7}{16}$	3	$\frac{5}{8}$	$4\frac{1}{8}$
3	$1\frac{7}{8}$	4	$4\frac{1}{4}$	$\frac{1}{4}$	$1\frac{1}{8}$	$\frac{5}{8}$	$1\frac{5}{16}$	1	$\frac{1}{2}$	$3\frac{1}{2}$	$\frac{3}{4}$	$4\frac{1}{2}$
$3\frac{1}{2}$	2	$4\frac{1}{2}$	5	$\frac{1}{4}$	$1\frac{1}{4}$	$\frac{3}{4}$	$1\frac{1}{2}$	$1\frac{1}{4}$	$\frac{1}{2}$	$4\frac{1}{2}$	1	5
4	2	$5\frac{1}{8}$	$5\frac{5}{8}$	$\frac{1}{4}$	$1\frac{3}{8}$	$\frac{3}{4}$	$1\frac{3}{4}$	$1\frac{1}{4}$	$\frac{1}{2}$	$5\frac{1}{8}$	1	$6\frac{3}{4}$
$4\frac{1}{2}$	$2\frac{1}{4}$	6	$6\frac{1}{2}$	$\frac{1}{4}$	$1\frac{3}{8}$	$\frac{13}{16}$	2	$1\frac{1}{4}$	$\frac{9}{16}$	$5\frac{1}{4}$	1	7
5	$2\frac{3}{8}$	$6\frac{1}{2}$	$7\frac{1}{2}$	$\frac{1}{2}$	$1\frac{1}{2}$	$\frac{13}{16}$	$2\frac{1}{4}$	$1\frac{1}{4}$	$\frac{9}{16}$	$6\frac{1}{4}$	1	$7\frac{1}{2}$
6	$2\frac{1}{2}$	$7\frac{1}{2}$	$8\frac{1}{2}$	$\frac{1}{2}$	$1\frac{1}{2}$	1	$2\frac{1}{2}$	$1\frac{1}{4}$	$\frac{3}{4}$	$7\frac{1}{2}$	1	$8\frac{1}{4}$
7	3	$9\frac{3}{8}$	$10\frac{3}{8}$	$\frac{1}{2}$	$1\frac{1}{2}$	1	3	$1\frac{1}{2}$	1	$8\frac{1}{2}$	1	10
8	3	$9\frac{3}{4}$	$10\frac{3}{4}$	$\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{4}$	$3\frac{1}{2}$	$1\frac{5}{8}$	$1\frac{1}{4}$	$9\frac{1}{2}$	1	$11\frac{1}{4}$
10					$1\frac{5}{8}$	$1\frac{3}{8}$	$4\frac{3}{8}$	$1\frac{1}{2}$	$1\frac{1}{4}$	11		
12					2	$1\frac{1}{2}$	$5\frac{1}{4}$					

Railing Fittings.

For fences around engines, machinery, exhibition spaces, etc., pipe and special shaped fittings are often used but ordinary plain or beaded fittings will answer as well.

These Special Railing Fittings are threaded right and left for convenience and hence the pipe will have threaded to suit. In most cases 1¼" pipe is used and sometines 1½" but the former will as a general thing be sufficient.

The gate may be arranged to swing or a single sliding bar as shown in Figure used, this made of a smaller size of pipe with a nut screwed back from the end to stop the bar in either end of its travel.



To construct a railing two pipes high, the upper outlet of all fitings used in lower pipes, should be tapped with left hand thread.

It is a general rule for supply stores to send right hand fittings unless specified. Since the fittings do not need to be steam or water tight a sufficiently clean thread to screw up well and make a good job may be made by running a left hand tap into any outlet tapped right hand.

A railing around a grass plot is generally 2′ 0″ above the walk and has only one pipe. For a two pipe railing, make A 20 to 21″ and B between 24 and 30″.

If three rails are desired the top one should be about 3′ 0″ from the floor and the other two spaced equally, if four rails, the top one 3′ 6″ from the floor. Railing fittings made of brass may be secured also.

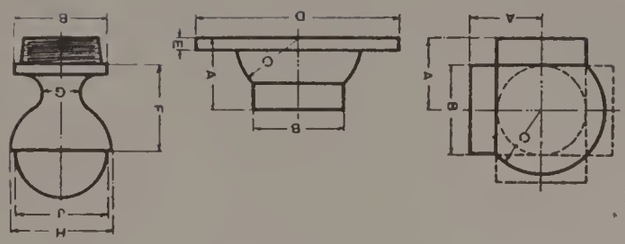


No. 1 may be secured with outlet pointing either up or down at an angle of 45°, also No. 3 with side up at the same angle. The cross No. 5 is made with center line at 45° and all are practically the shape of the fittings here shown.

In fact all can be secured with sides or runs at an angle of 45° but a sketch should accompany the order unless a catalog is secured.

The straight fiittngs are furnished by several firms but the 45° style only by the Western Tube Co., Kewanee, Ill. as far as investigation shows.

Dimensions of Railing Fittings.



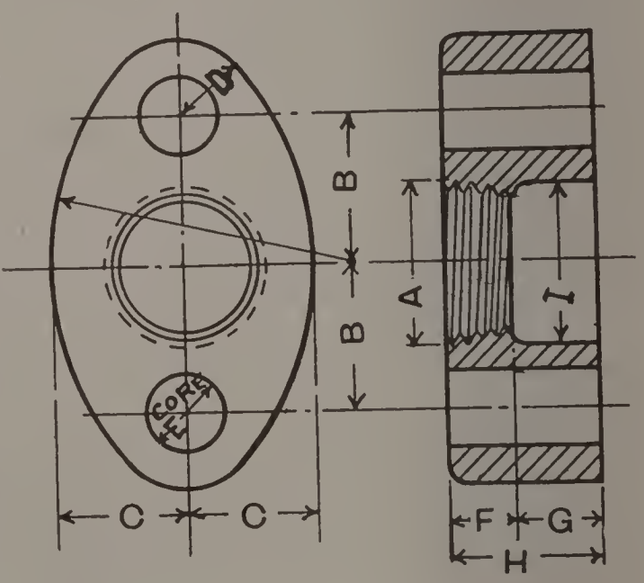
The dimension L is the distance center to center of holes in base D. From holes, in a base for wood screws.

Pipe Size	A	B	C	D	E	F	G	H	J	L
$\frac{3}{4}$	$1\frac{1}{4}$	$1\frac{1}{4}$	1	$2\frac{3}{4}$	$\frac{1}{4}$	$1\frac{1}{8}$	$\frac{7}{8}$	$1\frac{5}{16}$	$1\frac{7}{16}$	2
1	$1\frac{3}{8}$	$1\frac{5}{8}$	$1\frac{1}{8}$	3	$\frac{3}{8}$	1	$\frac{7}{8}$	2	$1\frac{3}{4}$	$2\frac{1}{4}$
$1\frac{1}{4}$	$1\frac{11}{16}$	2	$1\frac{5}{16}$	$3\frac{1}{2}$	$\frac{3}{8}$	$1\frac{1}{4}$	1	$1\frac{5}{8}$	$1\frac{1}{2}$	$2\frac{3}{4}$
$1\frac{1}{2}$	$1\frac{13}{16}$	$2\frac{1}{4}$	$1\frac{9}{16}$	4	$\frac{3}{8}$	$1\frac{1}{2}$	$1\frac{3}{16}$	$2\frac{1}{16}$	$1\frac{15}{16}$	$3\frac{1}{8}$
2	$2\frac{1}{4}$	$2\frac{7}{8}$	2	5	$\frac{3}{8}$	$1\frac{3}{4}$	$1\frac{3}{8}$	$2\frac{1}{4}$	$2\frac{1}{8}$	4

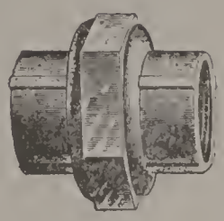
Railing Bases.

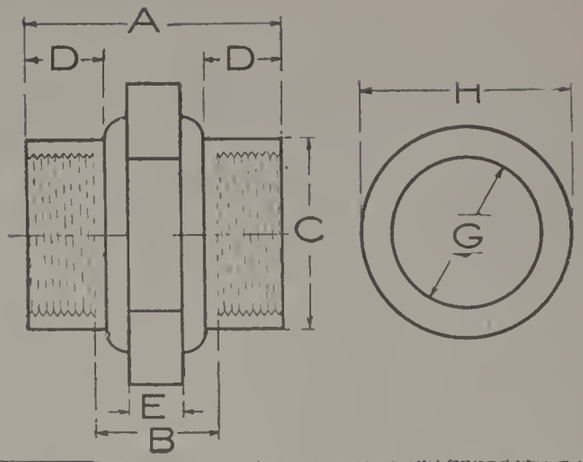
A = SIZE OF PIPE.

A	B	C	D	E	F	G	H	I
$\frac{1}{2}$	1	$\frac{15}{16}$	$\frac{5}{8}$	$\frac{9}{16}$	$\frac{3}{8}$	$\frac{5}{8}$	1	1
$\frac{3}{4}$	$1\frac{1}{4}$	$1\frac{1}{8}$	$\frac{5}{8}$	$\frac{9}{16}$	$\frac{1}{2}$	$\frac{3}{4}$	$1\frac{1}{4}$	$1\frac{5}{16}$
1	$1\frac{1}{2}$	$1\frac{5}{16}$	$\frac{3}{4}$	$\frac{11}{16}$	$\frac{5}{8}$	$\frac{7}{8}$	$1\frac{1}{2}$	$1\frac{5}{8}$
$1\frac{1}{4}$	$1\frac{3}{4}$	$1\frac{1}{2}$	$\frac{3}{4}$	$\frac{11}{16}$	$\frac{3}{4}$	1	$1\frac{3}{4}$	$1\frac{15}{16}$
$1\frac{1}{2}$	2	$1\frac{11}{16}$	$\frac{7}{8}$	$\frac{13}{16}$	$\frac{7}{8}$	$1\frac{1}{8}$	2	$2\frac{1}{4}$
2	$2\frac{1}{4}$	$1\frac{7}{8}$	$\frac{7}{8}$	$\frac{13}{16}$	1	$1\frac{1}{4}$	$2\frac{1}{4}$	$2\frac{9}{16}$



Malleable Iron Unions.





Size	1/8		3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4
A	1 1/4	1 1/4	1 5/8	1 7/8	2 1/4	2 3/8	2 5/8	2 7/8	3 1/4	3	3 3/4	4	4 5/8
B	5/8	5/8	7/8	1	1 1/8	1 1/4	1 1/4	1 3/8	1 3/4	1 3/4	2	2 1/4	2 1/2
C	5/8	5/8	13/16	1 1/16	1 5/16	1 9/16	1 7/8	2 1/8	2 5/8	3 1/4	3 7/8	4 3/4	5
D	3/8	3/8	7/16	9/16	3/4	13/16	7/8	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
E	3/8	1/2	1/2	1/2	1/2	9/16	9/16	5/8	5/8	3/4	7/8	7/8	7/8
F	1	1	1 1/4	1 9/16	1 1/4	2 1/4	2 5/8	2 15/16	3 1/2	4 3/8	4 7/8	5 3/4	6 1/4
G	3/8	3/8	5/8	3/4	15/16	1 1/8	1 1/2	1 11/16	2 1/2	2 3/4	3 1/4	3 3/4	4 3/8
H	3/4	3/4	15/16	1 1/4	1 1/2	1 3/4	2 1/8	1 3/8	3 1/4	3 3/4	4 3/8	4 3/4	5 1/2

Size Pipe inches	Diameter inches	Thickness inch	Equivalent To Cast Iron Inches.
3/4	6	5/16	1 1/2
1	6	5/16	1 1/2
1 1/4	6 1/2	5/16	1 1/2
1 1/2	7	3/8	1 1/2
2	8	3/8	2
2 1/2	8 1/2	3/8	2
3	9	3/8	2
3 1/2	9 1/2	7/16	2
4	10	7/16	2
4 1/2	10 1/2	1/2	2
5	11 1/2	1/2	2
6	12 1/2	1/2	2
7	14	5/8	2
8	15	5/8	2 1/4
9	16	3/4	2 1/4
10	17 1/2	3/4	2 1/4
12	20	13/16	2 1/4

Wrought Iron Flanges.



Cast Iron Fittings.

The standard cast iron fittings are well proportioned, of good weight and suitable to stand a working pressure of 150 pounds, although at various times and places. these fittings have been taken from stock and subjected to a hydraulic pressure of 1600 to 2500 pounds in order to break them.

It is evident from these tests that these fittings have a very large factor of safety, but as stated above, these fittings are not recommended for more than 150 pounds. working steam pressure.

It is not only a question of the fittings standing a higher pressure but also standing the strain of expansion, contraction, weightt of piping settling and water hammer; there is also a liability of their not running uniformly.

When fittings are wanted for a greater working preassure than 150 pounds, EXTRA HEAVY FITTINGS should be used which are suitable for 250 pounds working steam pressure.

As stated in another paragraph on these pages, to avoid the making of Special Fittings, the use of "bushings', are recommended.

Cast iron fiittings to stand 200 pounds air preasure or 250 pounds water pressure are made to order, prices according to quantity order.

Always state whether fittings are to be used for steam, water gas or air.

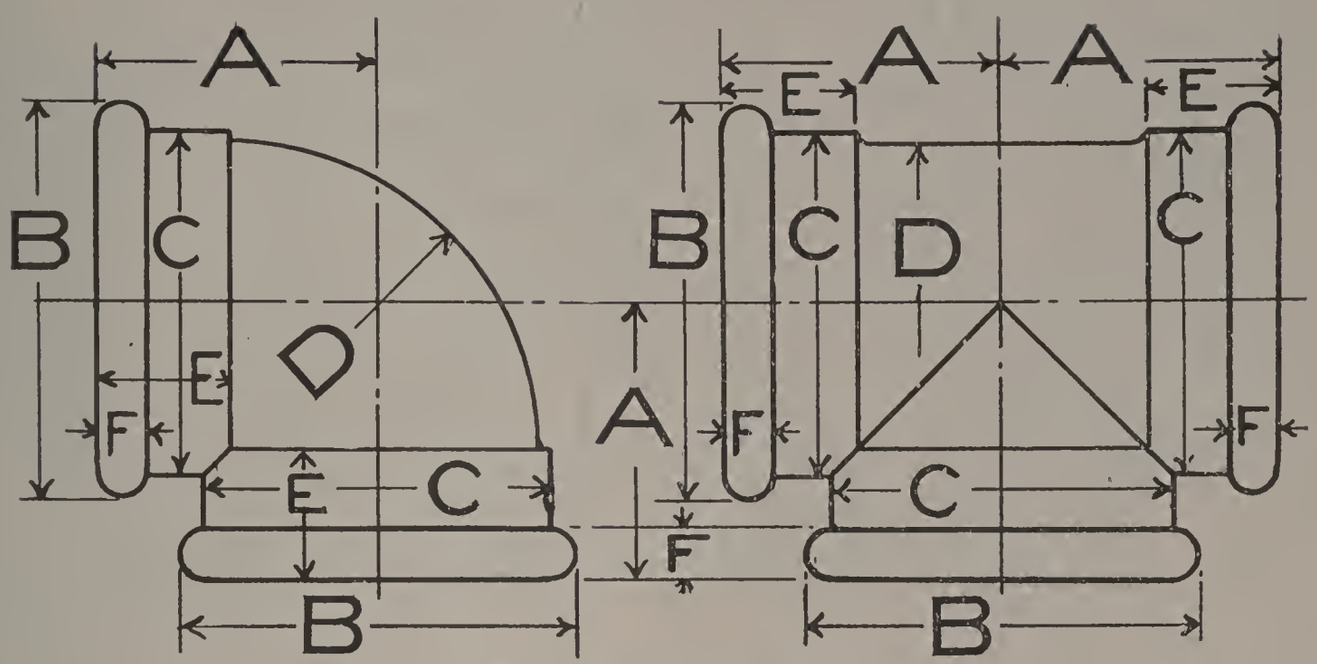
Cast iron 45° Elbows are made in the style shown beaded in sizes ranging from ⅜ up to and including 12″ but not reducing.

Right and left elbows from ¼ to 3″ inclusive. As in the case of malleable fittings the cast iron tees and elbows may be secured in sizes reducing in almost as great a variety. Y—branches in cast iron are made in sizes ½ to 8″ inclusive in 45° styles only.

Elbows slightly more than 90° known as "pitched" may be secured in styles ¾ to 40 inclusive. These are made to permit drainage.

Special eccentric reducers, bushings and tees may be secured in sizes 2 to 12″ inclusive, and tees on application.

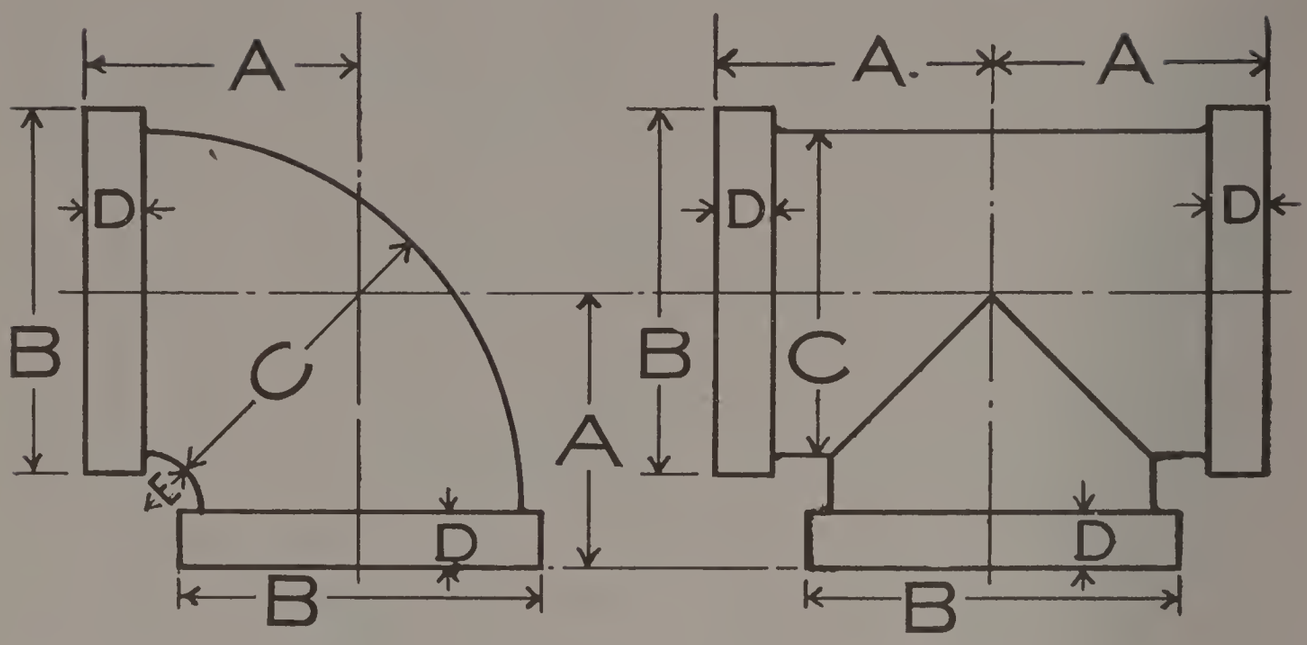
Cast Iron Elbows and Tees, Beaded,



D = DIA. OF BODY.

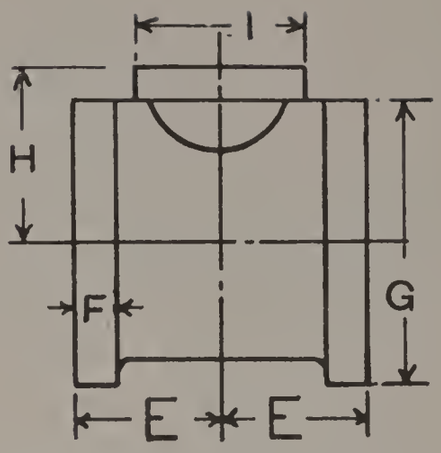
Size	A	B	C	D	E	F
$\frac{3}{8}$	$\frac{7}{8}$	$1\frac{1}{8}$	$1\frac{1}{8}$	1	$\frac{7}{16}$	$\frac{3}{16}$
$\frac{1}{4}$	$\frac{25}{32}$	1	$\frac{7}{8}$	$\frac{13}{16}$	$\frac{3}{8}$	$\frac{1}{8}$
$\frac{1}{2}$	$1\frac{1}{8}$	$1\frac{3}{8}$	$1\frac{3}{8}$	$1\frac{1}{2}$	$\frac{1}{2}$	$\frac{3}{16}$
$\frac{3}{4}$	$1\frac{5}{16}$	$1\frac{3}{4}$	$1\frac{5}{8}$	$1\frac{1}{2}$	$\frac{5}{8}$	$\frac{1}{4}$
1	$1\frac{1}{2}$	$2\frac{1}{8}$	$1\frac{15}{16}$	$1\frac{3}{4}$	$\frac{5}{8}$	$\frac{1}{4}$
$1\frac{1}{4}$	$1\frac{3}{4}$	$2\frac{3}{8}$	$2\frac{3}{16}$	2	$\frac{3}{4}$	$\frac{1}{4}$
$1\frac{1}{2}$	$1\frac{7}{8}$	$2\frac{3}{4}$	$2\frac{1}{2}$	$2\frac{3}{8}$	$\frac{3}{4}$	$\frac{1}{4}$
2	$2\frac{5}{16}$	$3\frac{3}{8}$	$3\frac{1}{8}$	$2\frac{13}{16}$	$\frac{13}{16}$	$\frac{5}{16}$
$2\frac{1}{2}$	$2\frac{3}{4}$	$4\frac{1}{8}$	$3\frac{11}{16}$	$3\frac{7}{16}$	1	$\frac{3}{8}$
3	3	$4\frac{7}{8}$	$4\frac{7}{16}$	$4\frac{1}{8}$	$1\frac{5}{8}$	$\frac{1}{2}$
$3\frac{1}{2}$	$3\frac{3}{8}$	$5\frac{1}{2}$	5		$1\frac{1}{8}$	$\frac{1}{2}$
4	$3\frac{3}{4}$	6	$5\frac{1}{2}$	$5\frac{3}{16}$	$1\frac{1}{8}$	$\frac{5}{8}$
$4\frac{1}{2}$	$4\frac{1}{8}$	$6\frac{1}{2}$	6	$5\frac{1}{2}$	$1\frac{1}{4}$	$\frac{5}{8}$
5	$4\frac{3}{8}$	$7\frac{1}{4}$	$6\frac{3}{4}$	$6\frac{1}{4}$	$1\frac{3}{8}$	$\frac{5}{8}$
6	$5\frac{1}{4}$	$8\frac{1}{2}$	8	$7\frac{1}{2}$	$1\frac{1}{2}$	$\frac{5}{8}$
7	6	$9\frac{3}{4}$	$8\frac{3}{4}$	$8\frac{1}{4}$	$1\frac{3}{4}$	$\frac{3}{4}$
8	$6\frac{1}{2}$	$10\frac{3}{4}$	$9\frac{3}{4}$	$9\frac{1}{4}$	$1\frac{3}{4}$	$\frac{3}{4}$
9	7	$12\frac{1}{2}$	$11\frac{3}{4}$	$11\frac{1}{2}$	2	$\frac{7}{8}$
10	8	$13\frac{1}{2}$	$12\frac{1}{2}$	12	2	$\frac{7}{8}$
12	$9\frac{1}{2}$	$15\frac{1}{2}$	$14\frac{1}{2}$	14	$2\frac{1}{2}$	1

Cast Iron Elbows and Tees, Square Bead.



	ELBOWS					TEES			
SIZE	A	B	C	D	E	A	B	C	D
$\frac{1}{4}$	$\frac{5}{8}$	1	$\frac{3}{4}$	$\frac{3}{8}$		$\frac{5}{8}$	1	$\frac{3}{4}$	$\frac{3}{8}$
$\frac{3}{8}$	$\frac{15}{16}$	$1\frac{1}{8}$	1	$\frac{3}{8}$		$\frac{15}{16}$	$1\frac{1}{8}$	1	$\frac{3}{8}$
$\frac{1}{2}$	$1\frac{1}{8}$	$1\frac{7}{16}$	$1\frac{1}{4}$	$\frac{1}{2}$		$1\frac{1}{8}$	$1\frac{7}{16}$	$1\frac{1}{4}$	$\frac{1}{2}$
$\frac{3}{4}$	$1\frac{5}{16}$	$1\frac{3}{4}$	$1\frac{1}{2}$	$\frac{1}{2}$		$1\frac{5}{16}$	$1\frac{3}{4}$	$1\frac{1}{2}$	$\frac{5}{8}$
1	$1\frac{9}{16}$	$2\frac{1}{8}$	$1\frac{13}{16}$	$\frac{5}{8}$		$1\frac{1}{2}$	2	$1\frac{3}{4}$	$\frac{5}{8}$
$1\frac{1}{4}$	$1\frac{5}{8}$	$2\frac{3}{8}$	$2\frac{1}{16}$	$\frac{3}{4}$		$1\frac{3}{4}$	$2\frac{9}{16}$	$2\frac{3}{16}$	$\frac{5}{8}$
$1\frac{1}{2}$	$1\frac{15}{16}$	$2\frac{13}{16}$	$2\frac{7}{16}$	$\frac{3}{4}$		2	$2\frac{7}{8}$	$2\frac{1}{2}$	$\frac{3}{4}$
2	$2\frac{1}{8}$	$3\frac{3}{8}$	$2\frac{15}{16}$	$\frac{3}{4}$		$2\frac{3}{16}$	$3\frac{3}{8}$	3	$\frac{3}{4}$
$2\frac{1}{2}$	$2\frac{1}{2}$	4	$3\frac{1}{2}$	$\frac{7}{8}$		$2\frac{7}{8}$	$4\frac{1}{8}$	$3\frac{1}{2}$	$1\frac{3}{16}$
3	3	$4\frac{5}{8}$	$4\frac{1}{8}$	1		3	$4\frac{7}{8}$	$4\frac{5}{16}$	$\frac{7}{8}$
$3\frac{1}{2}$	$3\frac{1}{4}$	$5\frac{1}{2}$	$4\frac{7}{8}$	$1\frac{1}{16}$		$3\frac{1}{4}$	$5\frac{1}{2}$	$4\frac{7}{8}$	$1\frac{1}{16}$
4	$3\frac{3}{4}$	6	$5\frac{1}{8}$	$1\frac{1}{8}$		$3\frac{3}{4}$	6	$5\frac{1}{2}$	$1\frac{1}{8}$
$4\frac{1}{2}$	$4\frac{1}{4}$	$6\frac{1}{2}$	$5\frac{3}{4}$	$1\frac{3}{16}$		$4\frac{3}{8}$	$6\frac{1}{2}$	$5\frac{5}{8}$	$1\frac{1}{8}$
5	$4\frac{1}{2}$	7	$6\frac{3}{8}$	$1\frac{1}{4}$		$4\frac{11}{16}$	7	$6\frac{3}{8}$	$1\frac{1}{8}$
6	$4\frac{3}{4}$	$8\frac{1}{4}$	$7\frac{1}{2}$	$1\frac{1}{4}$		$5\frac{1}{8}$	$8\frac{5}{8}$	$7\frac{5}{8}$	$1\frac{7}{16}$
7	$5\frac{7}{8}$	$9\frac{3}{4}$	9	$1\frac{3}{8}$		6	$9\frac{7}{8}$	$9\frac{1}{4}$	$1\frac{5}{8}$
8	$6\frac{1}{4}$	11	$9\frac{1}{2}$	$1\frac{1}{2}$		$6\frac{3}{8}$	11	$9\frac{3}{4}$	$1\frac{1}{2}$
10	$8\frac{11}{16}$	$13\frac{3}{8}$	$11\frac{13}{16}$	$1\frac{3}{4}$	1	$8\frac{3}{4}$	$13\frac{1}{2}$	$11\frac{7}{8}$	$1\frac{3}{4}$
12	11	$15\frac{1}{2}$	14	$1\frac{3}{4}$	$2\frac{3}{4}$	11	16	$14\frac{1}{2}$	$1\frac{3}{4}$

Size	E	F	G	H	I
3 x 3 x 4	$3\frac{5}{8}$	$\frac{7}{8}$	$4\frac{7}{8}$	$3\frac{1}{2}$	6
3 x 3 x $\frac{3}{4}$	$1\frac{3}{4}$	$\frac{7}{8}$	$4\frac{3}{4}$	2	$2\frac{1}{4}$
3 x 3 x 2	$2\frac{1}{2}$	$\frac{7}{8}$	$4\frac{3}{4}$	3	$3\frac{1}{2}$
3 x 3 x $1\frac{1}{2}$	$2\frac{1}{4}$	$\frac{7}{8}$	$4\frac{3}{4}$	3	3
3 x 3 x 2	$2\frac{1}{4}$	$\frac{7}{8}$	$4\frac{3}{4}$	2	$3\frac{1}{2}$
$3\frac{1}{2}$ x $3\frac{1}{2}$ x 4	$3\frac{5}{8}$	$1\frac{1}{16}$	$5\frac{3}{8}$	$5\frac{3}{8}$	6
$3\frac{1}{2}$ x $3\frac{1}{2}$ x $2\frac{1}{2}$	$2\frac{1}{2}$	$1\frac{1}{16}$	$5\frac{3}{8}$	$3\frac{1}{4}$	4
4 x 4 x $\frac{3}{4}$	2	$1\frac{1}{8}$	$6\frac{1}{8}$	$3\frac{1}{2}$	$1\frac{3}{4}$



A few sizes are given to show the maner in which reductions are made.

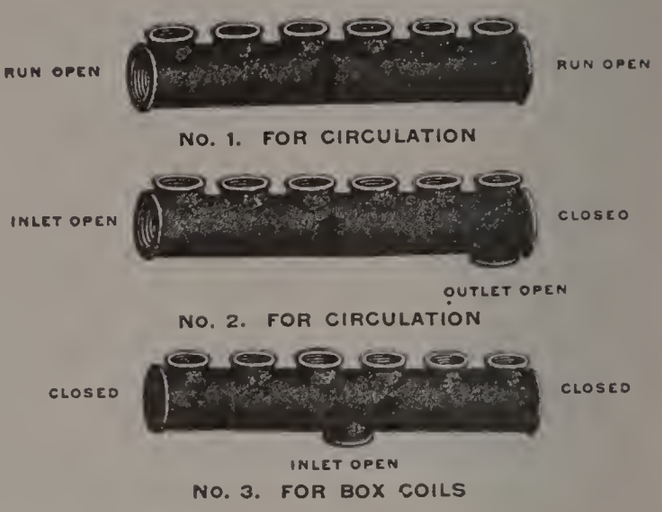
MEMORANDUM.

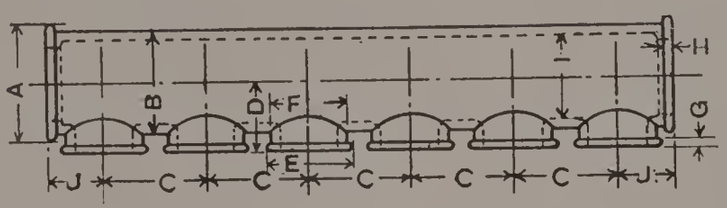
Branch Tees, Cast Iron.

All openings in Branch tees for Circulation are tapped right hand.

Branch tees for Box Coils are always tapped left hand in branches and right hand in back inlet.

The run and back opening of Branch Tees are tapped the same sizes as branch. unless otherwise ordered.





	1″ Branches		$1\frac{1}{4}$″ Branches	$1\frac{1}{2}$″ Branches	2″ Branches
	1″ or $1\frac{1}{4}$″ Run	$1\frac{1}{4}$ or 2″ Run	$1\frac{1}{4}$, $1\frac{1}{2}$, 2″ or $2\frac{1}{2}$ Run	$1\frac{1}{2}$, 2, $2\frac{1}{2}$ or 3″ Run	2, $2\frac{1}{2}$, 3 or $3\frac{1}{2}$″ Run
A	$2\frac{1}{4}$		$3\frac{1}{8}$	$3\frac{1}{2}$	$4\frac{1}{2}$
B	$2\frac{1}{8}$		3	$3\frac{1}{4}$	4
C	$2\frac{1}{2}$	$2\frac{1}{2}$	3	$3\frac{1}{2}$	$4\frac{1}{2}$
D	$1\frac{1}{2}$		2	$2\frac{1}{4}$	$2\frac{3}{4}$
E	$1\frac{5}{8}$		$1\frac{5}{8}$	2	$2\frac{1}{4}$
F	$1\frac{3}{4}$	$1\frac{3}{4}$	$2\frac{1}{4}$	$2\frac{3}{4}$	$2\frac{5}{16}$
G	$\frac{3}{16}$	$\frac{3}{16}$	$\frac{3}{16}$	$\frac{3}{16}$	$\frac{1}{4}$
H	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{5}{16}$
I	$1\frac{3}{4}$	$2\frac{1}{4}$	$2\frac{1}{2}$	$2\frac{3}{4}$	$3\frac{1}{2}$
No. Branches	2 to 9 Inclusive	2 to 16 Inclusive	3 to 17 Inclusive	3 to 12 Inclusive	3 to 10 Inclusive

Illustrations and note from Crane Co.

Cast Iron Return Bends.

Size	CENTER TO CENTER OF PIPES.							
	Close Patt.	Open Patt.	Flat Back	Back Outlet	Extra Wide Pattern.			
½	1¼							
¾	1½	1⅞		1⅞				
1	1¾	2⅜	3	2¼	3	4		
1			4		5	6		
1			6		8			
1¼	2¼	3	4	2¼	4			
1¼			6		6			
1¼			8					
1½	2½	3½		2½	4⅞	6	8	
2	3¼	4½		3¼	4⅞	6	7	8
2½	3¾	5½		5½				
3	4½	6½		6½				
4					7	11		

Return bends may be secured with openings slightly pitched for coils ranging from 3 to 8 feet in 1 inch and 1¼″ sizes only, thus permitting drainage in heater coils.

The back outlet of right and left return bends are always tapped right hand.

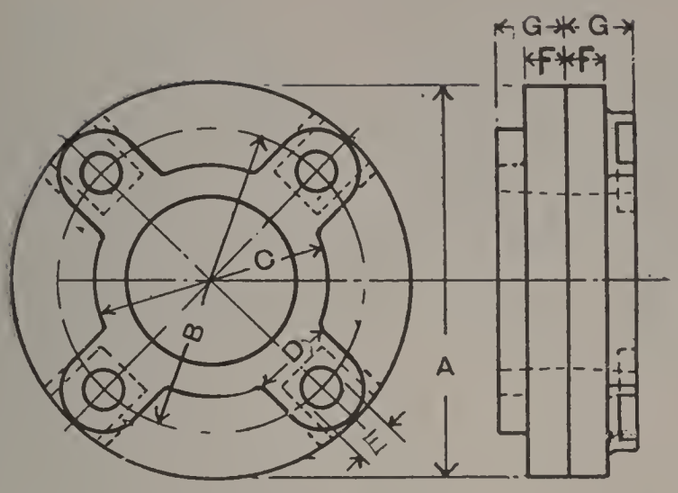
Dimensions should be taken for sizes as shown for beaded cast iron elbows.

Flanges,

There are two recognized standards for cast iron flanges at present in use. It has taken some time to bring about uniformity, but all the large manufacturers have now agreed to adopt the tables. This table is for steam pressure up the 125 pounds. This table was adopted by a joint committee of the American Society of Mechanical Engineers, the Master Steam Fitters, Association and the manufacturers. The other table for pressure up to 250 pounds was adopted at a meeting of manufacturers held in New York on June 28, 1901. It is generally referred to as the "Manufacturer's Standard". It would be a great convenience to all manufacturers of piping material and their customers if the Association of Steam Engine Builders would adopt these standards for all piping connections. The diversity in diameters and drilling of flanges on engines, pumps, condensers, is the cause of much trouble and delay.

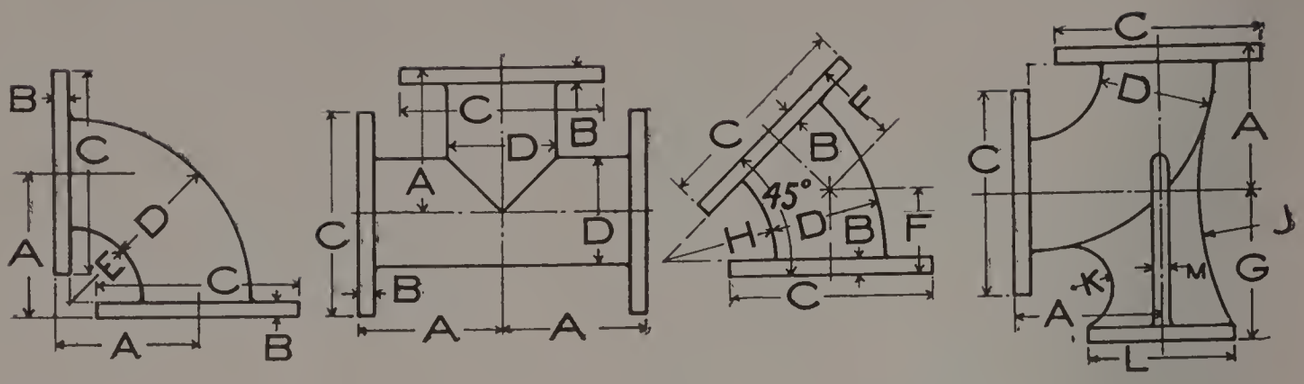
Pipe Size X Diam. Flange.	Diameter of Bolt Circle.	Number of Bolts.	Size of Bolts, Pressure under 80 lbs.	Size of Bolts, Pressure 80 lbs. and over.	Flange Thickness at Hub for Iron Pipe.	Flange Thickness at Edge.	Width of Flange Face.
2 x 6	4¾	4	½ x 2	⅝ x 2	1	⅝	2
2½ x 7	5½	4	½ x 2¼	⅝ x 2¼	1⅛	11/16	2¼
3 x 7½	6	4	½ x 2½	⅝ x 2½	1¼	¾	2¼
3½ x 8½	7	4	½ x 2½	⅝ x 2½	1¼	13/16	2½
4 x 9	7½	4	⅝ x 2¾	¾ x 2¾	1⅜	15/16	2½
4½ x 9¼	7¾	8	⅝ x 3	¾ x 3	1⅜	15/16	2⅜
5 x 10	8½	8	⅝ x 3	¾ x 3	1½	15/16	2½
6 x 11	9½	8	⅝ x 3	¾ x 3	1½	1	2½
7 x 12½	10¾	8	⅝ x 3¼	¾ x 3¼	1½	1 1/16	2¾
8 x 13½	11¾	8	⅝ x 3½	¾ x 3½	1¾	1⅛	2¾
9 x 15	13¼	12	⅝ x 3½	¾ x 3½	1¾	1⅛	3
10 x 16	14¼	12	¾ x 3⅝	⅞ x 3⅝	2	1 3/16	3
12 x 19	17	12	¾ x 3¾	⅞ x 3¾	2	1¼	3½
14 x 21	18¾	12	⅞ x 4¼	1 x 4¼	2	1⅜	3½
15 x 22¼	20	16	⅞ x 4¼	1 x 4¼	2	1⅜	3⅝
16 x 23½	21¼	16	⅞ x 4¼	1 x 4¼	2¼	1 7/16	3¾
18 x 25	22¾	16	1 x 4¾	1⅛ x 4¾		1 9/16	3½
20 x 27½	25	20	1 x 4¾	1⅛ x 4¾		1 11/16	3¾

Do not drill bolt holes on centre line but symmetrically each side.



Cast Iron Flange Unions.

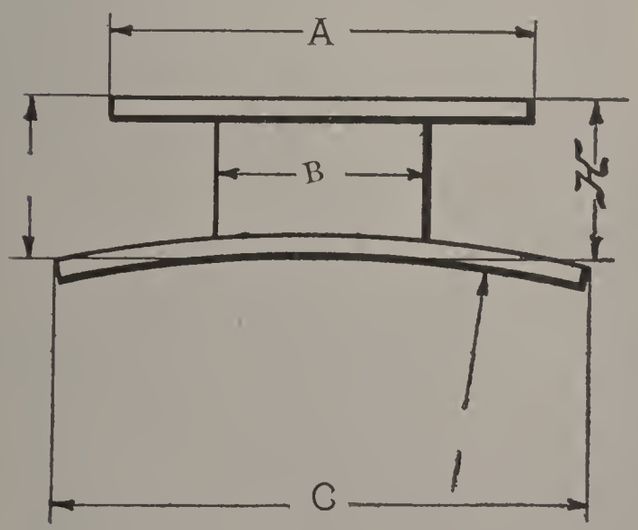
	A	B	C	D	E	F	G	H	No. and Size Bolts
$\frac{1}{2}$	3	2	$1\frac{1}{2}$	1	$\frac{7}{16}$	$\frac{5}{16}$	$\frac{5}{8}$	.....	3—$\frac{3}{8}$
$\frac{3}{4}$	$3\frac{5}{16}$	$2\frac{1}{4}$	$1\frac{3}{4}$	1	$\frac{7}{16}$	$\frac{5}{16}$	$\frac{5}{8}$	.....	3—$\frac{3}{8}$
1	$3\frac{5}{8}$	$2\frac{3}{4}$	$1\frac{7}{8}$	1	$\frac{1}{2}$	$\frac{7}{16}$	$\frac{3}{4}$	.....	3—$\frac{3}{8}$
$1\frac{1}{4}$	$4\frac{1}{8}$	$3\frac{1}{4}$	$2\frac{1}{4}$	$1\frac{1}{8}$	$\frac{1}{2}$	$\frac{7}{16}$	$\frac{3}{4}$	.....	4—$\frac{7}{16}$
$1\frac{1}{2}$	$4\frac{11}{16}$	$3\frac{3}{8}$	$2\frac{1}{2}$	$1\frac{1}{8}$	$\frac{1}{2}$	$\frac{7}{16}$	$\frac{13}{16}$	.....	4—$\frac{7}{16}$
2	$5\frac{1}{4}$	$3\frac{7}{8}$	$2\frac{7}{8}$	$1\frac{1}{8}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{7}{8}$	.....	4—$\frac{7}{16}$
$2\frac{1}{2}$	$6\frac{1}{16}$	$4\frac{3}{4}$	$3\frac{1}{2}$	$1\frac{1}{8}$	$\frac{9}{16}$	$\frac{9}{16}$	$\frac{7}{8}$	.....	4—$\frac{1}{2}$
3	$6\frac{3}{4}$	$5\frac{3}{8}$	$4\frac{1}{4}$	$1\frac{1}{4}$	$\frac{11}{16}$	$\frac{9}{16}$	$\frac{7}{8}$	.....	4—$\frac{5}{8}$
$3\frac{1}{2}$	$7\frac{1}{2}$	$5\frac{3}{4}$	$4\frac{3}{4}$	$1\frac{1}{4}$	$\frac{11}{16}$	$\frac{5}{8}$	1	.....	4—$\frac{5}{8}$
4	$8\frac{1}{8}$	$6\frac{3}{4}$	$5\frac{1}{2}$	$1\frac{1}{2}$	$\frac{11}{16}$	$\frac{5}{8}$	$1\frac{1}{8}$	.....	5—$\frac{5}{8}$
$4\frac{1}{2}$	$8\frac{13}{16}$	7	6	$1\frac{1}{2}$	$\frac{11}{16}$	$\frac{3}{4}$	$1\frac{1}{4}$	.....	5—$\frac{5}{8}$
5	$9\frac{1}{2}$	8	$6\frac{3}{8}$	$1\frac{1}{2}$	$\frac{11}{16}$	$\frac{3}{4}$	$1\frac{1}{4}$	.....	5—$\frac{5}{8}$
6	$10\frac{3}{4}$	$9\frac{1}{4}$	$7\frac{3}{4}$	$1\frac{1}{2}$	$\frac{11}{16}$	$\frac{13}{16}$	$1\frac{7}{16}$	.....	6—$\frac{5}{8}$
7	12	10	9	$1\frac{1}{2}$	$\frac{13}{16}$	$\frac{13}{16}$	$1\frac{1}{2}$	.....	7—$\frac{3}{4}$
8	$13\frac{1}{4}$	$11\frac{1}{2}$	$9\frac{1}{2}$	$1\frac{1}{2}$	$\frac{13}{16}$	1	$1\frac{3}{4}$	.....	7—$\frac{3}{4}$
10	16	$13\frac{1}{2}$	$11\frac{1}{2}$	$1\frac{3}{4}$	$\frac{13}{16}$	$1\frac{1}{8}$	2	.....	10—$\frac{3}{4}$
12	$18\frac{1}{4}$	17	14	$1\frac{3}{4}$	$\frac{13}{16}$	$1\frac{1}{4}$	2	.....	12—$\frac{3}{4}$



Size	A	B	C	D	E	F	G	H	Diam. of Bolt Circle	Size and No. Bolts
2	$4\frac{1}{2}$	$\frac{5}{8}$	6	$2\frac{7}{8}$	$2\frac{7}{16}$	2	5	$1\frac{7}{8}$	$4\frac{3}{4}$	4 — $\frac{5}{8}$
$2\frac{1}{2}$	5	$\frac{11}{16}$	7	$3\frac{3}{8}$	$2\frac{5}{8}$	$2\frac{1}{2}$	$5\frac{1}{2}$	$2\frac{5}{8}$	$5\frac{1}{2}$	4 — $\frac{5}{8}$
3	$5\frac{1}{2}$	$\frac{3}{4}$	$7\frac{1}{2}$	$3\frac{7}{8}$	$2\frac{13}{16}$	3	$5\frac{3}{4}$	$3\frac{1}{2}$	6	4 — $\frac{5}{8}$
$3\frac{1}{2}$	6	$\frac{13}{16}$	$8\frac{1}{2}$	$4\frac{1}{2}$	$2\frac{15}{16}$	$3\frac{1}{2}$	$6\frac{1}{4}$	$4\frac{3}{16}$	$6\frac{3}{4}$	4 — $\frac{5}{8}$
4	$6\frac{1}{2}$	$\frac{15}{16}$	9	5	$3\frac{1}{16}$	4	$6\frac{1}{2}$	$4\frac{7}{8}$	$7\frac{1}{4}$	8 — $\frac{5}{8}$
$4\frac{1}{2}$	7	$\frac{15}{16}$	$9\frac{1}{4}$	$5\frac{1}{2}$	$3\frac{5}{16}$	4	$6\frac{3}{4}$	$4\frac{7}{8}$	$7\frac{3}{4}$	8 — $\frac{5}{8}$
5	$7\frac{1}{2}$	$\frac{15}{16}$	10	6	$3\frac{9}{16}$	$4\frac{1}{2}$	7	$5\frac{5}{8}$	$8\frac{1}{4}$	8 — $\frac{5}{8}$
6	8	1	11	$7\frac{1}{8}$	$3\frac{7}{16}$	5	$7\frac{1}{2}$	$6\frac{1}{16}$	$9\frac{1}{4}$	8 — $\frac{5}{8}$
7	$8\frac{1}{2}$	$1\frac{1}{16}$	$12\frac{1}{2}$	$8\frac{1}{4}$	$3\frac{5}{16}$	$5\frac{1}{2}$	$8\frac{1}{4}$	$6\frac{7}{16}$	11	12 — $\frac{5}{8}$
8	9	$1\frac{1}{8}$	$13\frac{1}{2}$	$9\frac{1}{4}$	$3\frac{1}{4}$	$5\frac{1}{2}$	$8\frac{3}{4}$	$5\frac{15}{16}$	12	12 — $\frac{5}{8}$
9	10	$1\frac{1}{8}$	15	$10\frac{3}{8}$	$3\frac{11}{16}$	6	$9\frac{1}{2}$	$6\frac{9}{16}$	13	12 — $\frac{3}{4}$
10	11	$1\frac{3}{16}$	16	$11\frac{1}{2}$	$4\frac{1}{16}$	$6\frac{1}{2}$	10	$7\frac{1}{16}$	$14\frac{1}{4}$	12 — $\frac{3}{4}$
12	12	$1\frac{1}{4}$	19	$13\frac{5}{8}$	$3\frac{15}{16}$	$7\frac{1}{2}$	$10\frac{1}{2}$	$8\frac{1}{4}$	17	16 — $\frac{3}{4}$
14	14	$1\frac{3}{8}$	21	$15\frac{3}{4}$	$4\frac{3}{4}$	$7\frac{1}{2}$	$13\frac{1}{2}$	$7\frac{1}{16}$	$18\frac{1}{2}$	16 — $\frac{7}{8}$
15	$14\frac{1}{2}$	$1\frac{3}{8}$	$22\frac{1}{4}$	$16\frac{7}{8}$	$3\frac{11}{16}$	8	14	$7\frac{5}{16}$		
16	15	$1\frac{7}{16}$	$23\frac{1}{2}$	18	$4\frac{9}{16}$	8	$14\frac{3}{4}$	7	$21\frac{1}{2}$	20 — $\frac{7}{8}$

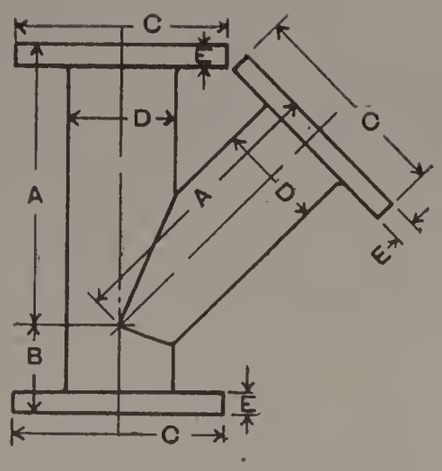
EXTRA HEAVY CAST IRON FLANGE FITTINGS.

Size	A	B	C	D	E	F	G	H	Bolt Circle	Size and No.
2	5	$\frac{7}{8}$	$6\frac{1}{2}$	3	$2\frac{5}{8}$	3	$5\frac{1}{2}$	$3\frac{5}{8}$	5	4 — $\frac{5}{8}$
$2\frac{1}{2}$	$5\frac{1}{2}$	1	$7\frac{1}{2}$	$3\frac{1}{2}$	$2\frac{3}{4}$	$3\frac{1}{2}$	6	$4\frac{3}{8}$	$5\frac{7}{8}$	4 — $\frac{5}{8}$
3	6	$1\frac{1}{8}$	$8\frac{1}{4}$	4	$2\frac{7}{8}$	$3\frac{1}{2}$	$6\frac{1}{4}$		$6\frac{5}{8}$	8 — $\frac{5}{8}$
$3\frac{1}{2}$	$6\frac{1}{2}$	$1\frac{3}{16}$	9	$4\frac{1}{2}$	$3\frac{1}{16}$	4	$6\frac{3}{4}$		$7\frac{1}{4}$	8 — $\frac{5}{8}$
4	7	$1\frac{1}{4}$	10	$5\frac{1}{4}$	$3\frac{1}{8}$	$4\frac{1}{2}$	7		$7\frac{7}{8}$	8 — $\frac{3}{4}$
$4\frac{1}{2}$	$7\frac{1}{2}$	$1\frac{5}{16}$	$10\frac{1}{2}$	$5\frac{7}{8}$	$3\frac{1}{4}$	$4\frac{1}{2}$	$7\frac{1}{4}$		$8\frac{1}{2}$	8 — $\frac{3}{4}$
5	8	$1\frac{3}{8}$	11	$6\frac{3}{8}$	$3\frac{7}{16}$	5	$7\frac{1}{2}$		$9\frac{1}{4}$	8 — $\frac{3}{4}$
6	$8\frac{1}{2}$	$1\frac{7}{16}$	$12\frac{1}{2}$	$7\frac{1}{2}$	$3\frac{5}{16}$	$5\frac{1}{2}$	8		$10\frac{5}{8}$	8 — $\frac{7}{8}$
7	9	$1\frac{1}{2}$	14	$8\frac{5}{8}$	$3\frac{3}{16}$	6	$8\frac{3}{4}$		$11\frac{7}{8}$	12 — $\frac{7}{8}$
8	10	$1\frac{5}{8}$	15	$9\frac{5}{8}$	$3\frac{9}{16}$	6	$9\frac{1}{4}$		13	12 — $\frac{7}{8}$
9	$10\frac{1}{2}$	$1\frac{3}{4}$	16	$10\frac{3}{4}$	$3\frac{3}{8}$	$6\frac{1}{2}$	10		14	12 — $\frac{7}{8}$
10	$11\frac{1}{2}$	$1\frac{7}{8}$	$17\frac{1}{2}$	$11\frac{1}{8}$	$4\frac{1}{16}$	7	$10\frac{1}{2}$		$15\frac{1}{4}$	12 — 1
12	13	2	20	14	4	8	11		$17\frac{3}{4}$	16 — 1
14	$14\frac{1}{2}$	$2\frac{1}{8}$	$22\frac{1}{4}$	$16\frac{1}{4}$	$4\frac{1}{4}$	8	14		$20\frac{1}{4}$	16 — 1
15	15	$2\frac{3}{16}$	$23\frac{1}{2}$	$17\frac{1}{4}$	$4\frac{3}{16}$	$8\frac{1}{2}$	$14\frac{1}{2}$		21	20 — 1
16	16	$2\frac{1}{4}$	25	$18\frac{3}{8}$	$4\frac{9}{16}$	9	$15\frac{1}{4}$		$22\frac{5}{8}$	20 — 1



Cast Iron Saddles

Dimensions A & B can be taken from the table of Standard Cast Iron Flanged Fittings' and R for the radius of boiler or tank. H should be between 8″ and 9″ on larger sizes.

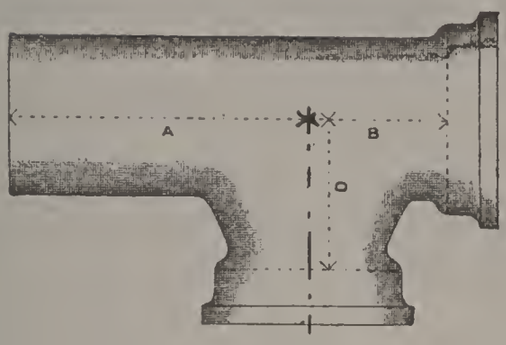


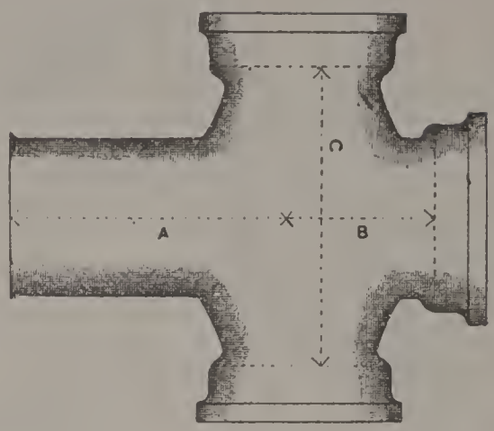
Standard Flanged Laterals.

For 125 lb. Pressure.

	A	B	C	D	E	F	Size and No.
2	8	$2\frac{1}{2}$	6	$2\frac{5}{8}$	$\frac{5}{8}$	$4\frac{3}{4}$	4 — $\frac{5}{8}$
$2\frac{1}{2}$	$9\frac{1}{2}$	$2\frac{1}{2}$	7	$3\frac{5}{8}$	$\frac{11}{16}$	$5\frac{1}{2}$	4 — $\frac{5}{8}$
3	10	3	$7\frac{1}{2}$	$3\frac{7}{8}$	$\frac{3}{4}$	6	4 — $\frac{5}{8}$
$3\frac{1}{2}$	$11\frac{1}{2}$	3	$8\frac{1}{2}$	$4\frac{1}{1}$	$\frac{13}{16}$	$6\frac{3}{4}$	4 — $\frac{5}{8}$
4	12	3	9	5	$\frac{15}{16}$	$7\frac{1}{4}$	8 — $\frac{5}{8}$
$4\frac{1}{2}$	$12\frac{1}{2}$	3	$9\frac{1}{1}$	$5\frac{1}{2}$	$\frac{15}{16}$	$7\frac{3}{4}$	8 — $\frac{5}{8}$
5	$13\frac{1}{2}$	$3\frac{1}{2}$	10	6	$\frac{15}{16}$	$8\frac{1}{4}$	8 — $\frac{5}{8}$
6	$14\frac{1}{2}$	$3\frac{1}{2}$	11	$7\frac{1}{8}$	1	$9\frac{1}{1}$	8 — $\frac{5}{8}$
7	$16\frac{1}{2}$	4	$12\frac{1}{2}$	$8\frac{1}{1}$	$1\frac{1}{16}$	11	12 — $\frac{5}{8}$
8	$17\frac{1}{2}$	$4\frac{1}{2}$	$13\frac{1}{2}$	$9\frac{1}{4}$	$1\frac{1}{8}$	12	12 — $\frac{5}{8}$
9	$19\frac{1}{2}$	$4\frac{1}{2}$	15	$10\frac{3}{8}$	$1\frac{1}{8}$	13	12 — $\frac{3}{4}$
10	$20\frac{1}{2}$	5	16	$11\frac{1}{2}$	$1\frac{3}{16}$	$14\frac{1}{1}$	12 — $\frac{3}{4}$
12	$24\frac{1}{2}$	$5\frac{1}{2}$	19	$13\frac{5}{8}$	$1\frac{1}{4}$	17	16 — $\frac{3}{4}$
14	27	6	21	$15\frac{3}{4}$	$1\frac{3}{8}$	$18\frac{1}{2}$	16 — $\frac{3}{4}$
15	$28\frac{1}{2}$	6	$22\frac{1}{4}$	$16\frac{7}{8}$	$1\frac{3}{8}$	20	16 — $\frac{7}{8}$
16	30	$6\frac{1}{2}$	$23\frac{1}{2}$	18	$1\frac{7}{16}$	$21\frac{1}{2}$	20 — 1

Bell and Spigot Pipe Fittings.



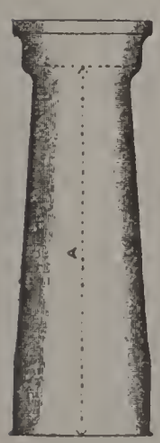


Dimensions of Tees.

Diam.	A.	B.	D.
3″	18″	8″	7½″
4″	18″	8″	7½″
5″	20″	9″	8½″
6″	20″	9″	8½″
8″	22″	10″	10″
10″	24″	11″	11½″
12″	26″	12″	13″
14″	28″	13″	14½″
16″	30″	14″	16″
18″	32″	15″	17½″
20″	34″	16″	19″
24″	36″	20″	22″

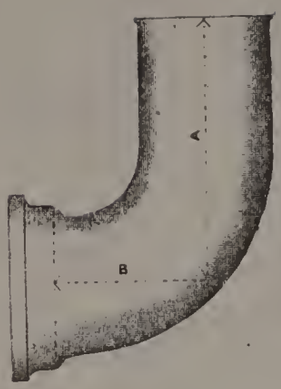
Dimensions of Crosses.

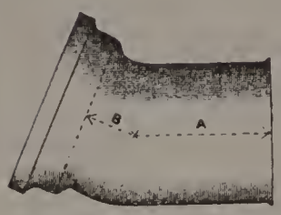
Diam	A.	B.	C.
3″	18″	8″	15″
4″	18″	8″	15″
5″	20″	9″	17″
6″	20″	9″	17″
8″	22″	10″	20″
10″	24″	11″	23″
12″	26″	12″	26″
14″	28″	13″	29″
16″	30″	14″	32″
18″	32″	15″	35″
20″	34″	16″	38″
24″	36″	20″	44″

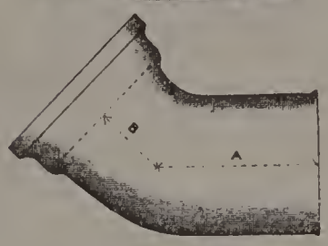


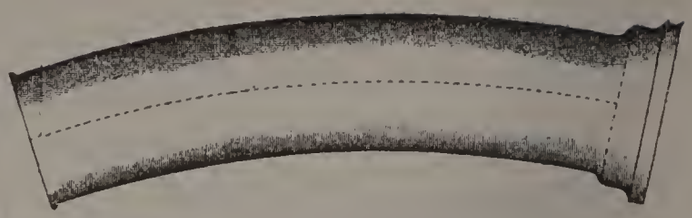
Dimensions of Reducers.

A.			A.			A.		
4 to	3	26	12 to	8	38	18 to	8	47
5 "	4	29	12 "	6	38	20 "	18	50
5 "	3	29	14 "	12	41	20 "	16	50
6 "	5	29	14 "	10	41	20 "	14	50
6 "	4	29	14 "	8	41	20 "	12	50
6 "	3	29	14 "	6	41	20 "	10	50
8 "	6	32	16 "	14	44	20 "	8	50
8 "	5	32	16 "	12	44	24 "	20	56
8 "	4	32	16 "	10	44	24 "	18	56
8 "	3	32	16 "	8	44	24 "	16	56
10 "	8	35	18 "	16	47	24 "	14	56
10 "	6	35	18 "	14	47	24 "	12	56
10 "	5	35	18 "	12	47	24 "	10	56
12 "	10	38	18 "	10	47			









Dimensions of Bends.

	90°		45°		22½°	
Diam.	A.	B.	A.	B.	A.	B.
3″	17″	7″	10″	4″	8″	3″
4″	18″	8″	11″	4″	9″	3″
5″	19″	9″	12″	5″	10″	3″
6″	20″	10″	13″	5″	11″	4″
8″	22″	12″	14″	6″	12″	4″
10″	24″	14″	15″	7″	13″	5″
12″	26″	16″	16″	8″	14″	5″
14″	28″	18″	17″	9″	15″	6″
16″	30″	20″	18″	10″	16″	6″
18″	32″	22″	19″	11″	17″	7″
20″	34″	24″	20″	12″	18″	7″
24″	38″	28″	22″	14″	20″	8″

Diam.	Radius.	Diam.	Radius.
3″	2′ 0″	14″	10′ 0″
4″	10′ 0″	14″	15′ 0″
4″	20′ 0″	14″	20′ 0″
4″	2′ 0″	16″	4′ 0″
6″	2′ 6″	16″	7′ 0″
6″	4′ 0″	16″	8′ 0″
6″	10′ 0″	16″	16′ 0″
6″	12′ 0″	16″	20′ 0″
6″	20′ 0″	18″	3′ 6″
8″	6′ 0″	18″	10′ 0″
8″	12′ 0″	18″	12′ 0″
8″	20′ 0″	18″	20′ 0″
10″	24′ 0″	20″	5′ 0″
10″	5′ 0″	20″	15′ 0″
10″	20′ 0″	20″	20′ 0″
10″	30′ 0″	20″	50′ 0″
10″	50′ 0″	24″	5′ 0″
12″	2′ 3″	24″	20′ 0″
12″	5′ 0″	24″	50′ 0″
12″	6′ 0″	24″	100′ 0″
12″	10′ 0″	30″	3′ 0″
12″	15′ 0″	30″	4′ 0″
12″	25′ 0″	30″	20′ 0″
12″	30′ 0″	36″	20′ 0″
12″	50′ 0″	36″	50′ 0″
14″	2′ 4″	42″	50′ 0″
14″	5′ 0″	48″	50′ 0″

MEMORANDUM

CHAPTER III.

VALVES.

In valves the call is now for straight Way type, A number of angle valves are still used on boiler or engines leads, but a globe valve on a plant of any magnitude is very exceptional. They are still used freely on small lines and whenever it is necessary to throttle the stream. Beyond this the gate valve has so many advantages that it has practically secured the market. To cover the range of power plant work, we have had to build four lines:

(1) Low pressure for exhaust and condensing lines.
(2) Standard for pressure not exceeding 125 pounds.
(3) Medium for pressure not exceeding 150 pounds.
(4) Extra heavy for pressure not exceeding 250 pounds.

Upon the low peressure line we have not made very exhaustive tests. further than to ascertain that the valves are tight at 50 pounds per square inch. The other lines have been thoroughly exploited on all except the very largest sizes. Boiling down the results and striking general averages we arrive at the following:

Standard valves 4″ to 8″ will burst at about 700 lbs.

Standard valves 10″ to 16′ wil burst at about 600 lbs.

The largest size we have not burst, but have tested the 18″ to 450 pounds and 20 to 30″ to 300 pounds pressure without injury.

The medium valves will withstand a pressure of about 500 pounds in excess of the standard.

Extra heavy valves 4 to 8″ burst at 1,600 to 1,900 pounds.

Extra heavy valves 10 to 16″ burst at 1,200 to 1,550 pounds.

The large sizes have not been destroyed but the 18″ has been subjected to 350 pounds and 20 and 24″ to 600 pounds without injury. The same thickness of body metal is used in the valves as given for flanged fittings. except that all gate valves have the metal increased at the top of the body to carry any settling strains.

The next point to ascertain was the maximum load which could be applied to the discs without causing a leak. This load was found to be in nearly all cases 80% of the ultimate strength of the body. It must be borne in mind that all pressure valves mentioned were of the solid wedge type. It is not possible to obtain equivalent results from parallel seated double disc valves, for the reason that the latter have two comparatively light faces set out by an internal wedging mechanism and the face exposed to pressure will spring under a load very much lesss than can be sustained by a solid wedge.

It has been the custom for many years to rib the bodies of high pressure valves. The ribs give a massive appearance and are desirable on that account from a standpoint of the selling department. but they serve no good purpose mechanically and are a detriment instead of an advantage. The distribution of metal is so uneven that shrinkage strains are set up all along the corners where the ribs join the body. making the metal porous. A ribbed valve will not stand any more pressure than one with a plain body, and the only point which might be argued in favor of the ribs would be that they stiffen the valve against strains due to settling in the line. It is not, however, very logical to guard against a possibility by setting up a number of internal strains, especially where a plain bodied valve can be designed which will take care of all strains reasonably to be anticipatd. We have concluded to abandon the ribs altogether and shall hereafter only make valves of that style on special orders.

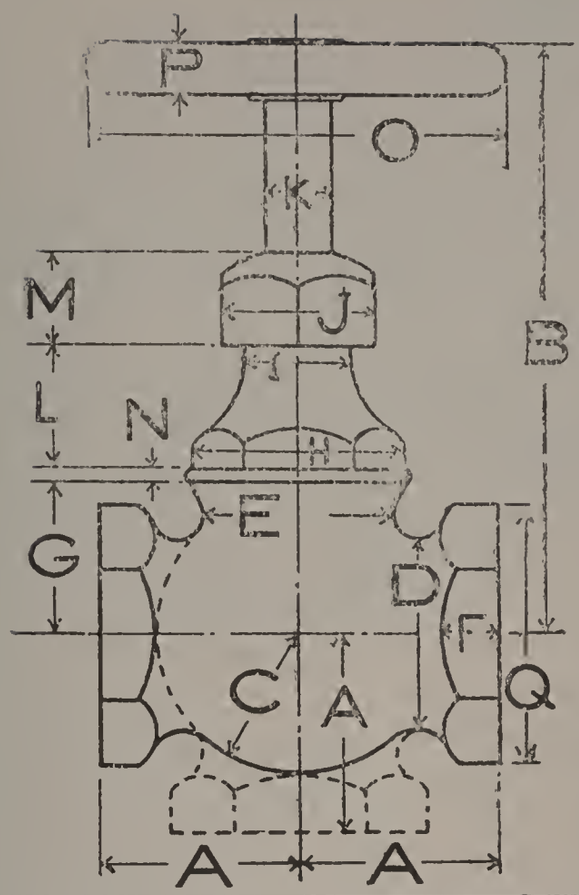
For high pressure work, we always recommend valves having outside screw and yoke, stationary wheel and rising spindle. In fact, for any service this type is preferable, except on the very large sizes where the great height from top of spindle when open, to the bottom of the valve. is a serious objection. The advantages over the internal screw valves are:

(1) The stem in indicator showing at all times the position of the disc.

(2) The thread on the stem is never in contact with the steam and can be properly lubricated.

(3) There is no thread on the wedge.

By-passes should be used on valves 8″ and larger when high steam pressure is used. The load on the wedge of an 8″ valve at 180 pounds pressure is 9.047 pounds and on a 16″ valve 36,190 pounds. It is obvious that under such loading the pressure must be partially equalized on each side of the wedge before the valve can opened with facillity.

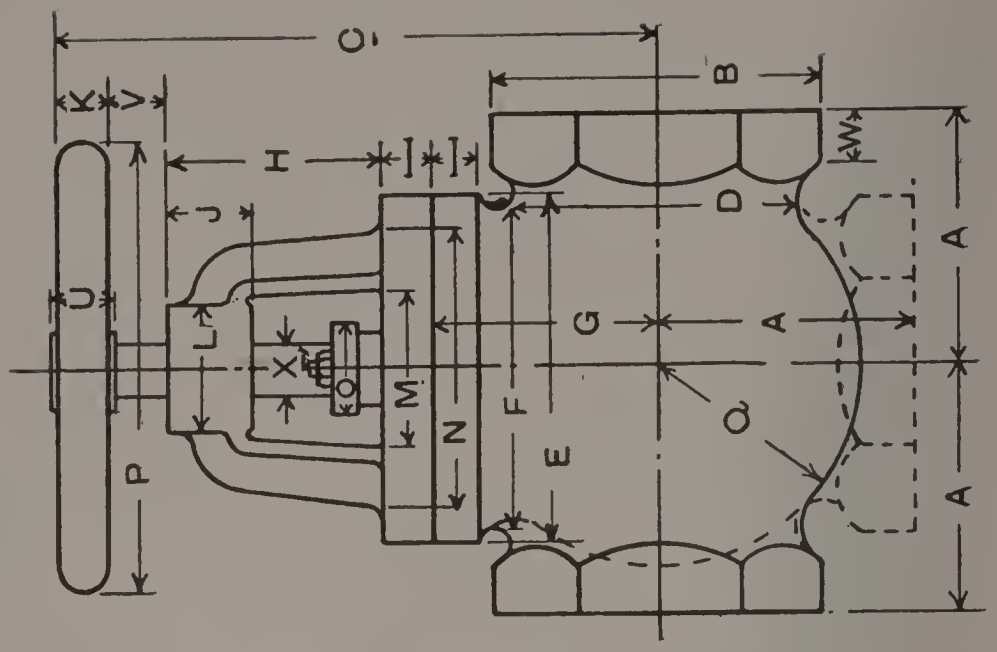


Globe, Angle and Cross Valves.

Brass

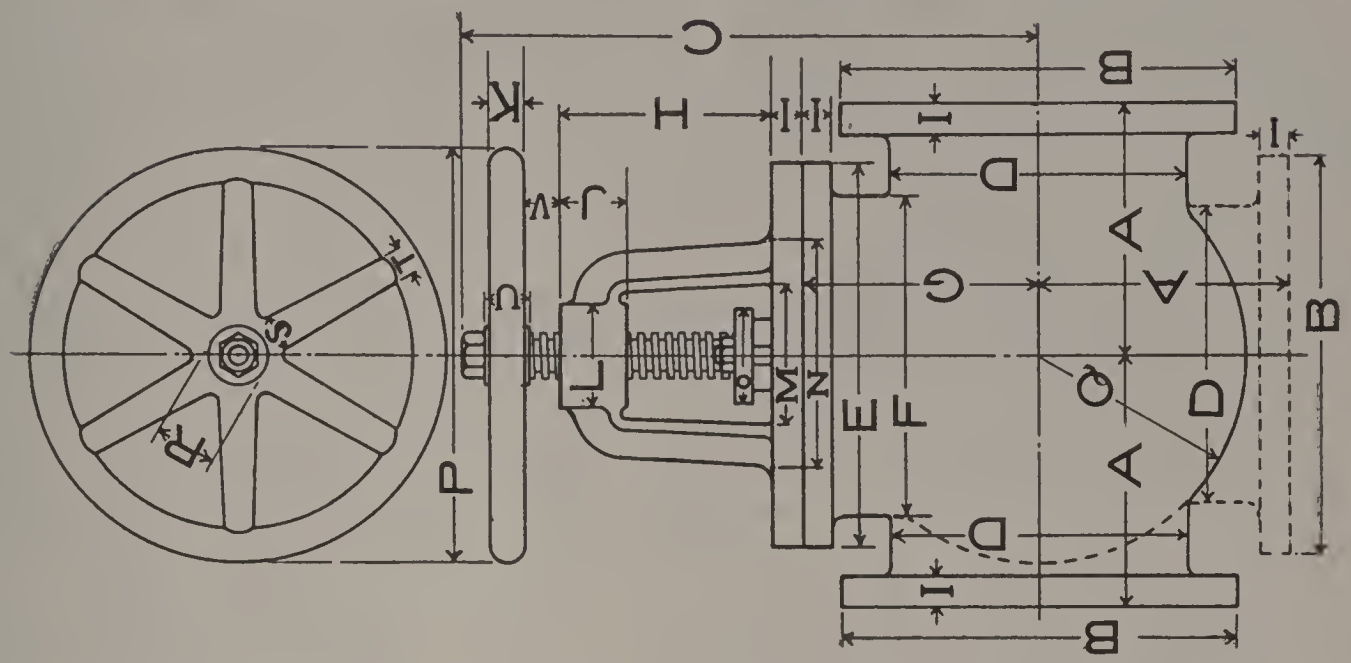
Size	⅛	⅜	½	¾	1	1¼	1½	2	2½	3
A	7/16	1 1/16	1 3/16	1 5/16	1⅝	1 13/16	2 1/16	2 5/16	4	4⅛
B	2⅜	3	3⅜	3¾	4½	5⅛	5¼	5⅝	7½	8½
C	9/16	⅝	⅞	1	1⅛	1¼	1⅝	2	3	3⅛
D	¾	⅞	1 1/16	1¼	1⅝	1¾	1⅞	2¾	3¼	4
E	1 1/16	¾	1¼	1⅝	1¾	2	2¼	2⅝	3⅛	4¼
F	5/16	5/16	⅜	⅜	7/16	7/16	⅝	⅝	⅞	1
G	⅝	¾	⅞	1⅛	1 3/16	1¼	1⅝	1⅝	2⅝	3
H	1 1/16	⅞	1	1¼	1½	1⅝	1¾	2¼	2¾	3⅛
I	½	½	⅝	1 1/16	¾	1 3/16	1 5/16	1¼	1⅜	1½
J	1 1/16	¾	⅞	1	1¼	1 5/16	1 9/16	1⅝	1¾	1¾
K	1/16	5/16	⅜	⅜	7/16	½	⅝	⅝	¾	⅞
L	½	9/16	1 1/16	⅞	1	1	1	1⅛	1⅛	1¼
M	⅜	½	9/16	⅝	¾	⅞	⅞	1	1¼	1½
N	1/16	1/16	⅛	⅛	3/16	3/16	¼	¼	⅜	⅜
O	1½	2	2	2¾	3	4	4½	4¾	6	6½
P	¼	5/16	½	⅜	7/16	½	9/16	9/16	¾	⅞
Q	⅞	1 1/16	1¼	1¼	2	2⅜	2¾	3⅜	4¾	5¼

Globe, Angle and Cross Valves. Iron Body, Screwed.



Size	$3\frac{1}{2}$	4	$4\frac{1}{2}$	5	6	8	10	12
A	$4\frac{1}{8}$	$4\frac{1}{16}$	$5\frac{1}{8}$	$5\frac{5}{8}$	$6\frac{1}{4}$	8	$9\frac{3}{4}$	11
B	$5\frac{3}{4}$	$6\frac{1}{2}$	$8\frac{1}{2}$	$8\frac{1}{2}$	$9\frac{1}{2}$			
C	$9\frac{1}{2}$	12	$12\frac{1}{2}$	$14\frac{1}{2}$	16			
D	$4\frac{3}{4}$	5	6	7	8			
E	$6\frac{3}{4}$	$7\frac{1}{2}$	$8\frac{1}{4}$	9	11			
F	6	7	8	9	10			
G	4	$4\frac{1}{4}$	5	$5\frac{1}{2}$	9			
H	3	$3\frac{1}{2}$	4	$4\frac{1}{2}$	$5\frac{1}{2}$			
I	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{7}{8}$	$\frac{7}{8}$	1			
J	$1\frac{3}{4}$	2	$2\frac{1}{8}$	$2\frac{1}{1}$	$2\frac{3}{8}$			
K	1	1	1	1	$1\frac{1}{8}$	$1\frac{1}{8}$	$1\frac{1}{8}$	$1\frac{1}{4}$
L	2	$2\frac{1}{4}$	$2\frac{1}{2}$	3	$3\frac{1}{2}$			
M	$3\frac{1}{2}$	4	$4\frac{1}{2}$	5	6			
N	$5\frac{1}{2}$	6	$6\frac{1}{2}$	7	9			
O								
P	$7\frac{1}{2}$	9	9	10	12	14	15	18
Q	$3\frac{1}{2}$	4	$4\frac{3}{4}$	$5\frac{1}{2}$	6			
U								
V	$\frac{3}{4}$	1	1	1	$1\frac{1}{4}$			
W								
X	1	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$

Globe, Angle and Cross Valves. Iron Body, Flanged.



	2	2½	3	3½	4	4½	5	6	7	8	10	12	14	15	16
A	4	4½	5¼	4¾	5½	6	6½	7	8	8½	10	12	14	14	16
B	6	7	7½	8½	9	9¼	10	11	12½	13½	16	19	21	22¼	23½
C			10½					15		23					
D		4	4¼	4¼				8		10					
E		6	7	7½				9½		14					
F			7	5				8		10¾					
G		4¼	3½	5				6		8					
H			5	6				6½		10					
I	5/8	1 1/16	3/4	1 3/16	15/16	15/15	15/16	1	1 1/16	1⅛	1 3/16	1¼	1⅜	1⅜	1 7/16
J			1¼					2		2¼					
K		7/8	1	1				1		1⅛					
L			2					2¾		3½					
M			3¼					4½		5					
N			5½					7¼		7¾					
O			2½					2½		3¼					
P	5½	6½	7½	7½	9	9	10	12	14	15	18	20	24	24	30
Q		3¼	3¾	4				5		7					
R		1½	1½					1¾		1⅞					
S			7/8					1		1¼					
T			1 1/16					7/8		7/8					
U		1	1⅛	⅛						1½					
V										1½					
W			5½					5		5¾					
X								3½		4½					

Check Valves.

Check valves are are placed in a pipe system to stop the flow in one direction and are made in several styles, the ordinary type in sizes from ⅛ to 4″ inclusive, with screwed end and from ¾ to 4″ inclusive, flanged.

The dimensions may be taken as for globe valves as far as the body is concerned.

Vertical and angle check valves may be secured in sizes from ⅛ to 2″ inclusive,

The seats of check valves are arranged for either a conical, a ball a flat or a swing valve to rest upon them. the latter made ⅜ to 3″ inclusive.

The illustrations show a horizontal, a vertical and an angle check valve made by Crane Co, Chicago.

The above applies to brass valves and bodies.

Cast iron check valves. horizontal, with screwed ends are made in sizes 2 to 12″ and flanged 2 to 15 inclusive, but 14 to 15″ sizes are made to order only.

Vertical check valves screwed and flanged, 2½ to 10″ inclusive and angle checks screwed and flanged in sizes 2 to 8″ inclusive,

Swing checks are made 2½ to 14″ inclusive, either screwed or flanged and the dimensions may be taken as for iron body globe valves and this will also apply where a swing check is wanted for heavy pressure.

Brass extra heavy check valves are made ¾ to 2″ inclusive.

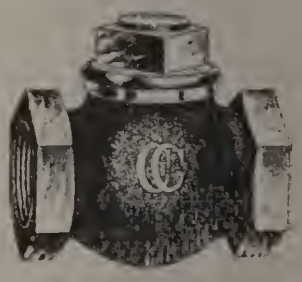
ANGLE

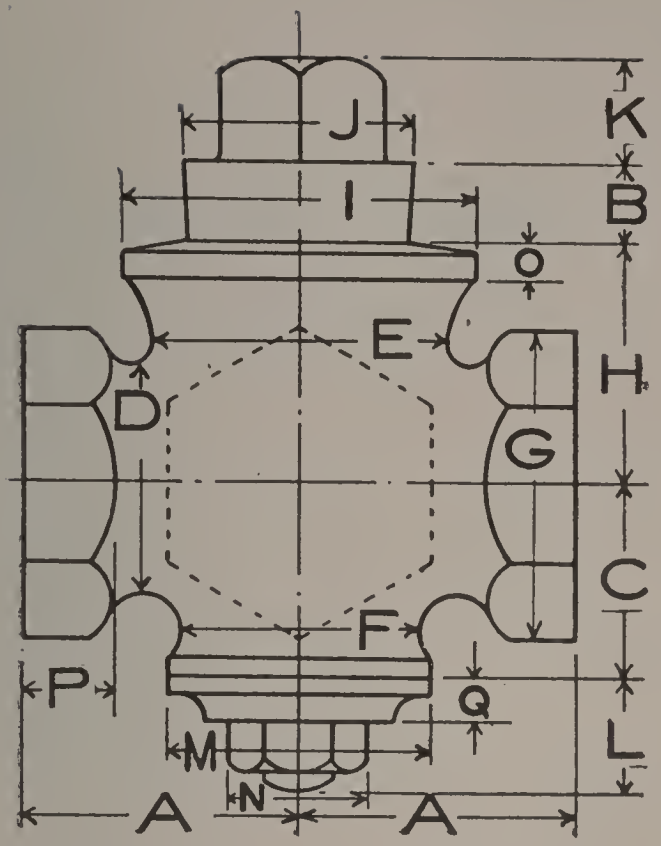


VERTICAL



HORIZONTAL





Stop Cocks.



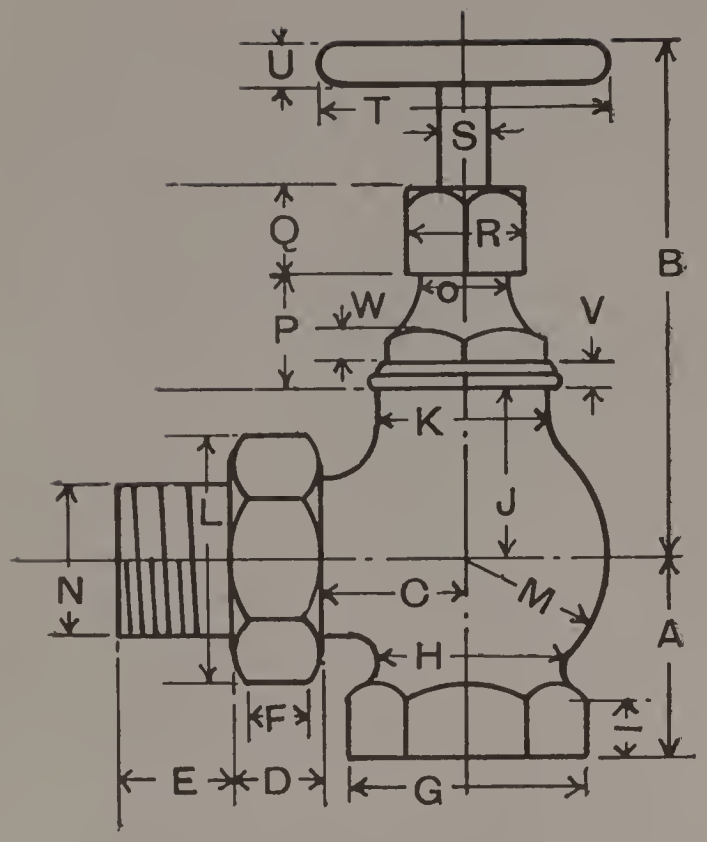
Three
Way Cock.

DIMENSIONS OF STEAM COCKS.

SIZE	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	1 3	3	5	3	3	5	7	5	1 3	9	5	11	3	1	1	3	1
$\frac{1}{4}$	$1\frac{3}{16}$	$\frac{3}{16}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{5}{8}$	$\frac{7}{8}$	$\frac{5}{8}$	$1\frac{3}{16}$	$\frac{9}{16}$	$\frac{5}{16}$	$1\frac{1}{16}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{1}{16}$	$\frac{3}{16}$	$\frac{1}{8}$
$\frac{3}{8}$	$1\frac{5}{16}$	$\frac{1}{4}$	$1\frac{1}{16}$	$1\frac{3}{16}$	$\frac{7}{8}$	$\frac{3}{4}$	1	$1\frac{1}{16}$	$1\frac{5}{16}$	$\frac{3}{4}$	$\frac{7}{16}$	$\frac{3}{4}$	$\frac{3}{8}$	$\frac{5}{8}$	$\frac{1}{16}$	$\frac{3}{16}$	$\frac{1}{8}$
$\frac{1}{2}$	$1\frac{1}{16}$	$\frac{1}{4}$	$\frac{7}{8}$	1	$1\frac{5}{16}$	$1\frac{3}{16}$	$1\frac{5}{16}$	$\frac{7}{8}$	1	$\frac{7}{8}$	$\frac{1}{2}$	$1\frac{3}{16}$	$\frac{1}{2}$	$1\frac{1}{16}$	$\frac{1}{8}$	$\frac{5}{16}$	$\frac{3}{16}$
$\frac{3}{4}$	$1\frac{1}{2}$	$\frac{3}{8}$	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{5}{8}$	$1\frac{5}{16}$	$1\frac{1}{2}$	$1\frac{1}{8}$	$1\frac{1}{2}$	$1\frac{1}{4}$	$\frac{9}{16}$	$1\frac{7}{16}$	$\frac{5}{8}$	$\frac{7}{8}$	$\frac{1}{8}$	$\frac{3}{8}$	$\frac{1}{4}$
1	$1\frac{9}{16}$	$\frac{3}{8}$	$1\frac{3}{16}$	$1\frac{1}{2}$	$1\frac{5}{8}$	$1\frac{1}{2}$	$1\frac{7}{8}$	$1\frac{1}{4}$	$1\frac{13}{16}$	$1\frac{1}{2}$	$\frac{11}{16}$	$1\frac{1}{2}$	$\frac{5}{8}$	$\frac{7}{8}$	$\frac{1}{8}$	$\frac{7}{16}$	$\frac{1}{4}$
$1\frac{1}{4}$	$1\frac{3}{4}$	$\frac{3}{8}$	$1\frac{3}{8}$	$1\frac{3}{4}$	$1\frac{5}{8}$	$1\frac{7}{16}$	$2\frac{1}{4}$	$1\frac{3}{8}$	$1\frac{7}{8}$	$1\frac{5}{8}$	$\frac{3}{4}$	$1\frac{5}{8}$	$\frac{13}{16}$	$1\frac{1}{16}$	$\frac{3}{16}$	$\frac{1}{2}$	$\frac{1}{4}$
$1\frac{1}{2}$	$1\frac{15}{16}$	$\frac{1}{2}$	$1\frac{5}{8}$	$2\frac{1}{8}$	$2\frac{1}{8}$	$1\frac{3}{4}$	$2\frac{5}{8}$	$1\frac{5}{8}$	$2\frac{1}{1}$	$1\frac{3}{4}$	$\frac{7}{8}$	$1\frac{7}{8}$	$\frac{15}{16}$	$1\frac{1}{4}$	$\frac{3}{16}$	$\frac{9}{16}$	$\frac{3}{8}$
2	$2\frac{3}{8}$	$\frac{1}{2}$	$1\frac{7}{8}$	$2\frac{3}{4}$	$2\frac{1}{16}$	$2\frac{3}{8}$	$3\frac{3}{8}$	2	$2\frac{15}{16}$	$2\frac{3}{16}$	1	$2\frac{1}{8}$	1	$1\frac{11}{16}$	$\frac{3}{16}$	$\frac{9}{16}$	$\frac{1}{2}$
$2\frac{1}{2}$	$2\frac{13}{16}$	$\frac{5}{8}$	$2\frac{1}{2}$	$3\frac{1}{8}$	$3\frac{3}{8}$	$2\frac{7}{8}$	$4\frac{1}{1}$	$2\frac{5}{8}$	$3\frac{3}{4}$	$3\frac{1}{8}$	$1\frac{1}{1}$	$3\frac{3}{8}$	$1\frac{1}{2}$	$1\frac{7}{4}$	$\frac{1}{4}$	$\frac{3}{4}$	$\frac{5}{8}$
3	$3\frac{1}{16}$	$\frac{5}{8}$	3	4	$4\frac{1}{8}$	$3\frac{1}{2}$	$4\frac{7}{8}$	$3\frac{3}{8}$	$4\frac{5}{8}$	$3\frac{5}{8}$	$1\frac{3}{8}$	$3\frac{3}{4}$	$1\frac{1}{2}$	$2\frac{1}{8}$	$\frac{1}{4}$	$\frac{7}{8}$	$\frac{5}{8}$

M-SIDE OF SQUARE HEAD.

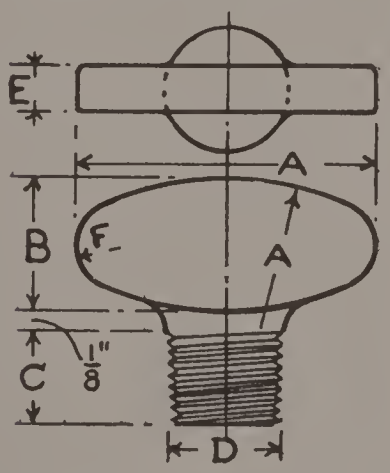
MEMORANDUM.



Radiator Valves.

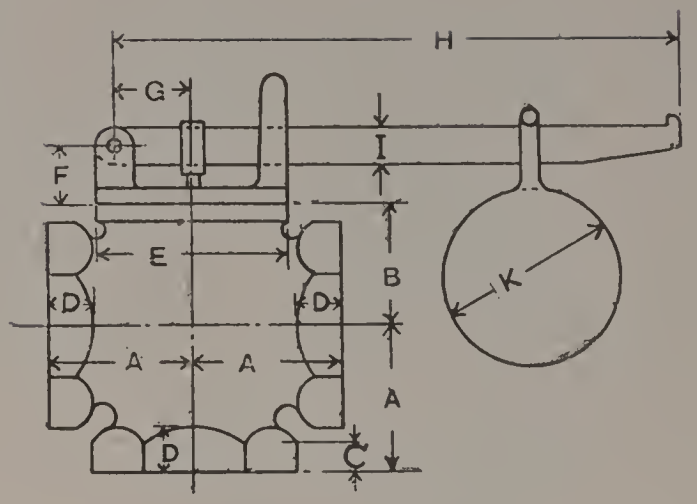
	$\frac{1}{2}$	$\frac{3}{4}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$	2
A	$1\frac{1}{4}$	$1\frac{3}{8}$	$1\frac{3}{4}$	$1\frac{3}{4}$	2	$2\frac{5}{8}$
B	$4\frac{1}{4}$	$4\frac{1}{2}$	5	$5\frac{1}{4}$	6	7
C	$1\frac{1}{8}$	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$2\frac{1}{8}$
D	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{7}{8}$	1
E	$1\frac{1}{8}$	1	1	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{3}{4}$
F	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{5}{8}$	$1\frac{1}{16}$
G	$1\frac{1}{2}$	$1\frac{3}{4}$	2	$2\frac{3}{8}$	$2\frac{3}{4}$	$3\frac{3}{8}$
H	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{7}{8}$	$2\frac{1}{8}$	$2\frac{5}{8}$
I	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{5}{8}$
J	1	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{5}{8}$	$2\frac{1}{8}$
K	$1\frac{1}{4}$	$1\frac{3}{8}$	$1\frac{1}{2}$	$1\frac{7}{8}$	$2\frac{1}{8}$	3
L	$1\frac{3}{4}$	$1\frac{5}{8}$	2	$2\frac{3}{8}$	$2\frac{7}{8}$	$3\frac{3}{8}$
M	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{15}{16}$	$1\frac{1}{8}$	$1\frac{5}{16}$	$2\frac{1}{16}$
N	$\frac{13}{16}$	1	$1\frac{5}{16}$	$1\frac{1}{16}$	$1\frac{7}{8}$	$2\frac{3}{8}$
O	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{7}{8}$	$\frac{7}{8}$	1
P	$1\frac{1}{8}$	$1\frac{1}{8}$	$1\frac{1}{8}$	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{1}{2}$
Q	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{7}{8}$	1
R	1	1	1	$1\frac{1}{8}$	$1\frac{1}{8}$	$1\frac{3}{8}$
S	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{7}{16}$	$\frac{9}{16}$
T	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{5}{8}$	3	3
U	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{15}{16}$
V	$\frac{3}{16}$	$\frac{3}{16}$	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{5}{16}$
W	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{5}{8}$

Brass Plugs.

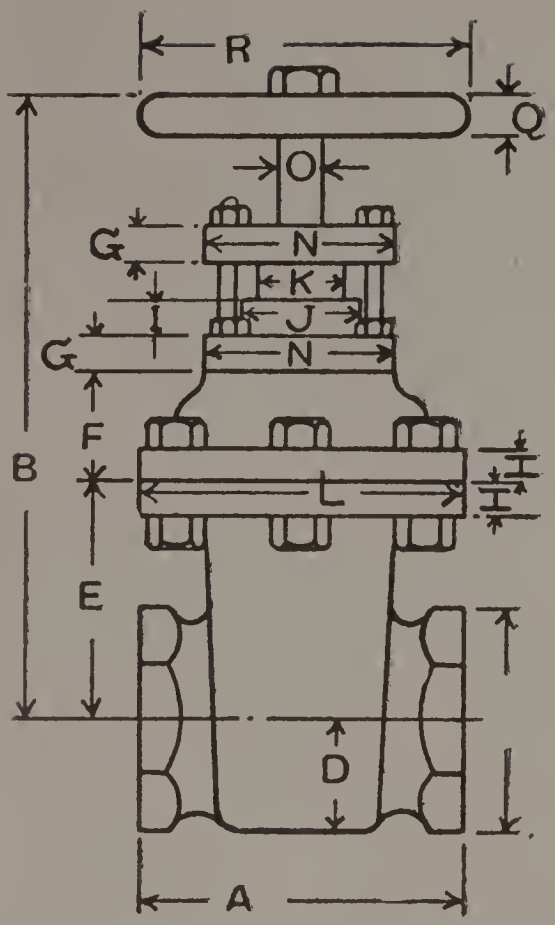


Pipe	A	B	C	D	E	F
$\frac{1}{8}$	$1\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{8}$	$1\frac{3}{32}$	$\frac{1}{8}$	$\frac{1}{8}$
$\frac{1}{4}$	$1\frac{1}{2}$	$\frac{5}{8}$	$\frac{7}{16}$	$1\frac{7}{32}$	$\frac{3}{16}$	$\frac{3}{16}$
$\frac{3}{8}$	$1\frac{3}{4}$	$\frac{3}{4}$	$\frac{1}{2}$	$\frac{43}{64}$	$\frac{1}{4}$	$\frac{1}{4}$
$\frac{1}{2}$	2	$\frac{7}{8}$	$\frac{9}{16}$	$2\frac{7}{32}$	$\frac{5}{16}$	$\frac{1}{4}$
$\frac{3}{4}$	$2\frac{1}{4}$	1	$\frac{5}{8}$	$1\frac{3}{64}$	$\frac{3}{8}$	$\frac{5}{16}$
1	$2\frac{1}{2}$	$1\frac{1}{8}$	$1\frac{1}{16}$	$1\frac{5}{16}$	$\frac{7}{16}$	$\frac{3}{8}$

Iron Body, Brass Mounted.



Size.	1¼	1½	2	2½	3	3½	4	4½	5	6	7	8
A	1⅞	2⅜	2⅞	3⅜	3¾	4¼	4½	5	5½	6¼	7	8
B	1½	2	2½	2⅝	3½	4	4¼	4½	4½	5	6	7
C	⅜	½	⅝	¾	¾	¾	⅞	1	1	1⅛	1⅛	1⅛
D	½	⅝	⅝	¾	⅞	1	1¼	1¼	1¼	1½	1½	1½
E	2	2½	3¼	5½	7	7¼	7½	8	9	9½	10	10½
F	1¾	2	2¼	2	2¼	2½	2¾	2¾	2¾	3	3¼	4
G	1	1	1¼	1¾	2½	2½	2½	2½	3	3¼	3½	3½
H	22	24	24	30	36	36	38	38	40	40	42	42
I	¾	⅞	⅞	1¼	1½	1½	1¾	1¾	2	2	2	2
J	⅛	⅛	3/16	¼	⅜	⅜	½	½	½	½	½	½
K	4	4½	5¾	6	7	8	8	9	9	9	9	9
W	10	15	25	40	61¼	70	70	100	100	100	100	100
L	2¼	2¾	3½	4	4½	5¼	6	7	7½	8¼	9½	10½



Gate Valves

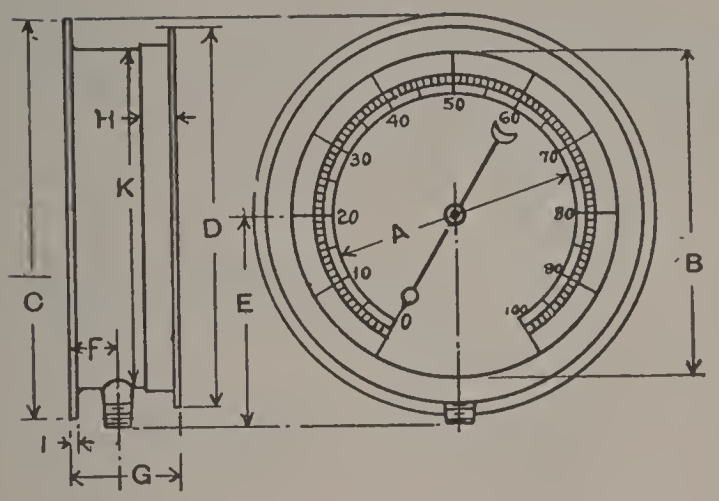
P=Short dimension of Gland N.

M=Long dimension of Flange L.

Size	2	2½	3	3½	4	4½	5	6	8
A	5½			6⅜	7½		8¼	9¼	10
B	12½			14	15½		17	20½	25
C									
D	1⅞						4½		6
E	4			5½	5¾		6	6¾	9½
F	1⅞			4	5		5½	6	7½
G	⅝			⅝	⅝		⅝	¾	1
H	9/16			⅝	⅝		⅞		1
I									
J									
K	1½			1⅞	2		2¼	2¼	2½
L	5½			6¼	7½		8	8½	9
M									
N				3½	4		4½	5	5½
O	¾			15/15	1		1⅛	1⅛	1¼
P									
Q	¾			⅞	⅞		1⅛	1⅛	1¼
R	5½			7½	8¾		11½	12	13½

CHAPTER IV.

MISCELLANEOUS ARTICLES.



Steam Gages.

All gages should be connected with the boiler by means of a Syhon. (See Chapter on Pipe)

Nominal Size	A	B	C	D	E	F	G	H	I	J	K
$3\frac{1}{2}$	$2\frac{1}{2}$	$3\frac{1}{8}$	$4\frac{3}{4}$	$4\frac{1}{4}$	$2\frac{1}{1}\frac{1}{6}$	$\frac{3}{4}$	$1\frac{1}{1}\frac{3}{6}$	$\frac{5}{8}$	$\frac{3}{3\,2}$	$\frac{1}{4}$	$3\frac{3}{4}$
$4\frac{1}{2}$	$3\frac{1}{8}$	$4\frac{1}{8}$	$5\frac{1}{8}$	$5\frac{3}{8}$	$3\frac{1}{4}$	$\frac{3}{4}$	$2\frac{1}{8}$	$\frac{1}{1}\frac{1}{6}$	$\frac{1}{8}$	$\frac{1}{4}$	$4\frac{3}{4}$
5	$3\frac{1}{2}$	$4\frac{1}{2}$	$5\frac{3}{4}$	6	$3\frac{3}{8}$	$\frac{3}{4}$	$2\frac{1}{4}$	$\frac{3}{4}$	$\frac{1}{8}$	$\frac{1}{4}$	$5\frac{1}{2}$
$5\frac{1}{2}$	4	5	$6\frac{3}{4}$	$6\frac{3}{8}$	$3\frac{1}{2}$	$\frac{1}{1}\frac{3}{6}$	$2\frac{1}{4}$	$\frac{1}{1}\frac{3}{6}$	$\frac{1}{8}$	$\frac{1}{4}$	$5\frac{3}{4}$
6	$4\frac{1}{2}$	$5\frac{3}{4}$	$7\frac{7}{8}$	$7\frac{3}{8}$	4	$\frac{7}{8}$	$1\frac{3}{8}$	$\frac{1}{1}\frac{3}{6}$	$\frac{1}{8}$	$\frac{1}{4}$	$6\frac{3}{8}$
$6\frac{3}{4}$	$5\frac{3}{8}$	$6\frac{1}{4}$	$8\frac{1}{2}$	8	$4\frac{5}{8}$	$\frac{7}{8}$	$2\frac{3}{8}$	$\frac{7}{8}$	$\frac{5}{8\,2}$	$\frac{1}{4}$	$7\frac{1}{8}$
$8\frac{1}{2}$	6	$7\frac{1}{2}$	$10\frac{1}{8}$	$9\frac{1}{2}$	5	$\frac{7}{8}$	$2\frac{1}{2}$	1	$\frac{5}{3\,2}$	$\frac{1}{4}$	$9\frac{5}{8}$
10	$7\frac{1}{4}$	$9\frac{1}{2}$	13	$11\frac{3}{4}$	7	$1\frac{1}{8}$	$2\frac{7}{8}$	$1\frac{1}{8}$	$\frac{3}{1\,6}$	$\frac{1}{2}$	$10\frac{3}{4}$

Brass Cock for Steam Gage.



Dimension of stock cocks.
length over all 1 5-16″
center to out edge of handle $1\frac{1}{8}$″
length of handle 1 5-16″
diameter bead $\frac{3}{4}$
“ next to bead 9-16″

Water Columns.

DIMENSIONS OF COLUMNS

NO.	1	2	3	4	5
A	13	16½	18¾	20	27½
B	10	12	13¾	14	22
C	2½	3	3⅜	3	5
D	2½	3	3½	4	5
E	1½	1¾	2	2½	3¼
F	8½	10	12	12½	20
G	½	½	¾	¾	¾
H	1½	1½	2	2½	3
I	3	3⅝	4¼	4¾	5⅞
J	1½	1½	2	2	2
K	1½	1½	2	2	2
L	⅜	½	⅝	⅝	¾
M	⅛	⅛	3/16	3/16	¼
N	⅜	½	⅝	⅝	¾
O	⅜	½	½	⅝	⅝
P	2⅞	3⅛	4	4½	5¼
Q	2¾	2¾	3¾	3¾	3¾
R	⅜	⅜	½	½	½
S	½	½	½	½	½
T	⅜	⅜	½	½	½
U	½	½	⅝	⅝	⅝
V	¼	¼	⅝	⅝	⅝
W	¾	¾	1	1	1
X	2¼	2¼	2½	2½	2½
Y	5/16	5/16	⅜	⅜	⅜
Z	1¼	1¼	1¾	1¾	1¾
Tapped for Gage Cock	½	½	¾	¾	¾
Water Gages.	½	½	¾	¾	¾
Tap in Top & Bottom.	¾	¾	1	1¼	1¼

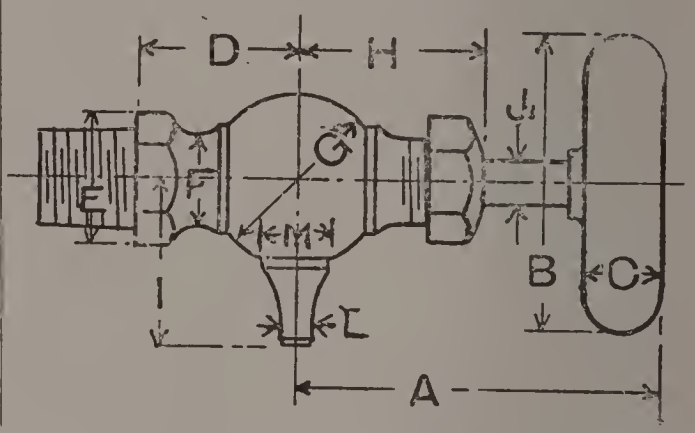
The tapping in the boiler for water column connections should be the same as shown in the table for the tap and bottom openings.

The columns should be connected so that the bottom gage cock (not the cock of the glass) would be 3″ above the top row of tubes or at a point where the lowest water lever occurs.

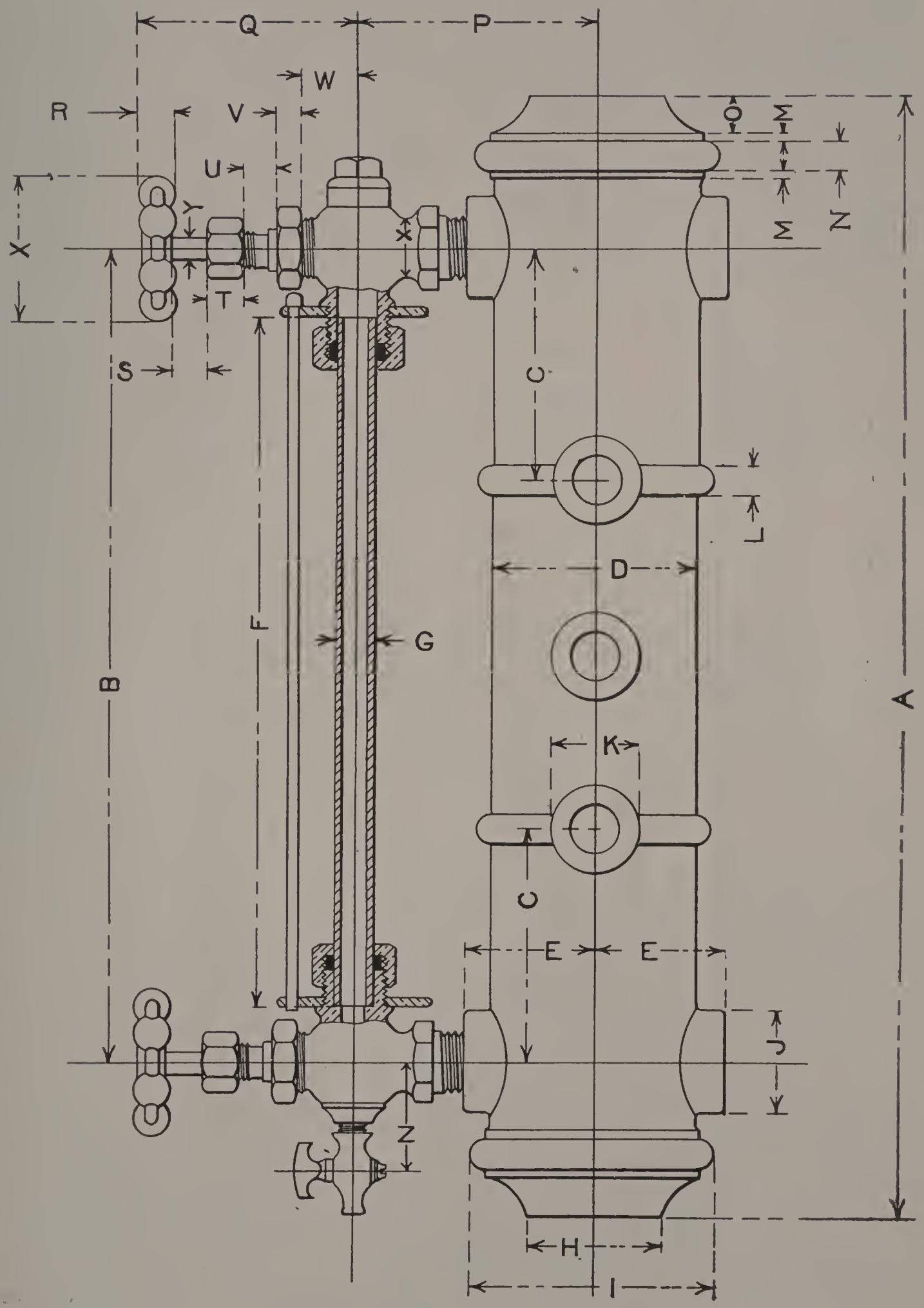
Valves in connections between column and boiler are dangerous and seldom ever needed, hence it is suggested that they should not be placed there at all. Run all pipes levels.

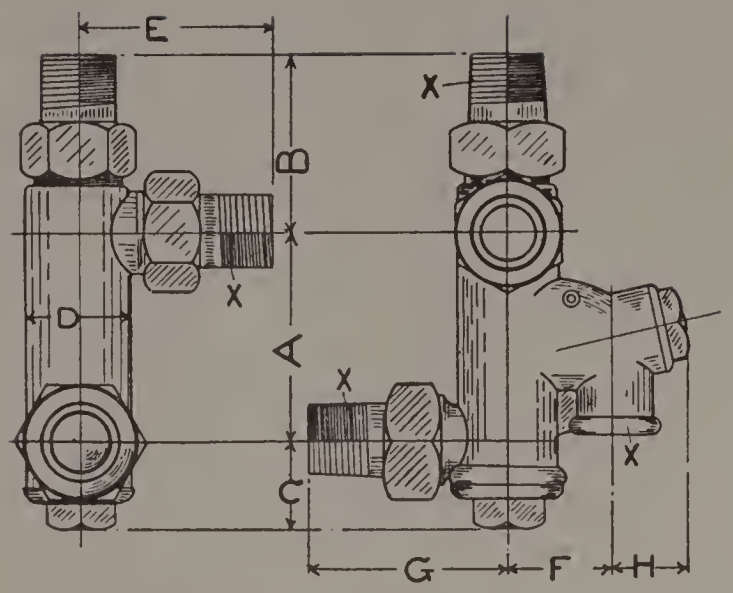
Some provision in the lower connections should be made for blowing out the column.

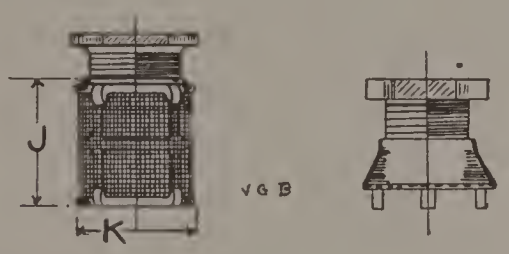
Compression Gage Cocks.



Size	½	¾
A	2¾	3¼
B	2¼	2½
C	⅝	¾
D	1 3/16	1½
E	1	1 5/16
F	⅝	1
G	9/16	¾
H	1⅜	1⅝
I	1¼	1½
J	5/16	½
K	¾	1
L	¼	¼
M	½	⅝

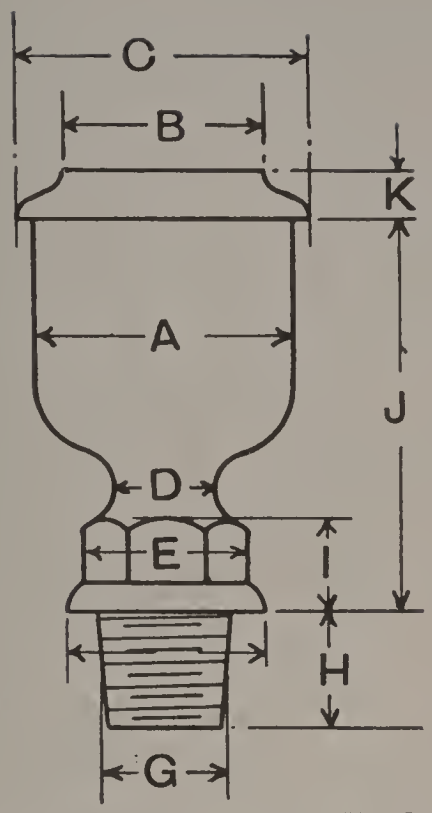

Q
P
W
R
V
U
Y
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T
S
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Σ
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C
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D
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E
J
Z
H
I
A





Penberty Injectors.

Injector No.	Thread X	Gal. per Hour	Horse Power	A	B	C	D	E	F	G	H	J	K	Y
0 0	$\frac{3}{8}$ Pipe	55	4–8	$1\frac{11}{16}$	2	$1\frac{5}{16}$	$1\frac{1}{4}$	$2\frac{1}{4}$	$1\frac{1}{4}$	$2\frac{5}{16}$	1	$2\frac{1}{4}$	$1\frac{1}{2}$	$\frac{1}{2}$
A	$\frac{1}{2}$ "	70	8–16	$2\frac{3}{8}$	$2\frac{7}{16}$	$1\frac{3}{16}$	$1\frac{3}{8}$	$2\frac{3}{8}$	$1\frac{1}{2}$	$2\frac{5}{8}$	$1\frac{1}{8}$	$2\frac{1}{4}$	$1\frac{1}{2}$	$\frac{3}{4}$
A A	$\frac{1}{2}$ "	90	12–22	$2\frac{3}{8}$	$2\frac{7}{16}$	$1\frac{3}{16}$	$1\frac{3}{8}$	$2\frac{3}{8}$	$1\frac{1}{2}$	$2\frac{5}{8}$	$1\frac{1}{8}$	$2\frac{1}{4}$	$1\frac{1}{2}$	$\frac{3}{4}$
B	$\frac{3}{4}$ "	135	17–32	$2\frac{15}{16}$	$2\frac{3}{4}$	$1\frac{5}{16}$	$1\frac{9}{16}$	$2\frac{13}{16}$	$1\frac{5}{8}$	3	$1\frac{1}{8}$	$2\frac{1}{4}$	$1\frac{3}{4}$	1
B B	$\frac{3}{4}$ "	165	20–45	$2\frac{15}{16}$	$2\frac{3}{4}$	$1\frac{5}{16}$	$1\frac{9}{16}$	$2\frac{13}{16}$	$1\frac{5}{8}$	3	$1\frac{1}{8}$	$2\frac{1}{4}$	$1\frac{3}{4}$	1
C	1 "	300	40–65	$3\frac{3}{8}$	$3\frac{1}{8}$	$1\frac{9}{16}$	$1\frac{3}{4}$	$3\frac{3}{8}$	$1\frac{7}{8}$	$3\frac{3}{8}$	$1\frac{3}{8}$	$2\frac{1}{4}$	2	$1\frac{1}{4}$
C C	1 "	350	45–80	$3\frac{3}{8}$	$3\frac{1}{8}$	$1\frac{9}{16}$	$1\frac{3}{4}$	$3\frac{3}{8}$	$1\frac{7}{8}$	$3\frac{3}{8}$	$1\frac{3}{8}$	$2\frac{1}{4}$	2	$1\frac{1}{4}$
D	$1\frac{1}{4}$ "	400	50–100	$4\frac{5}{16}$	$3\frac{5}{8}$	$1\frac{13}{16}$	$2\frac{1}{4}$	$3\frac{15}{16}$	$2\frac{1}{4}$	$3\frac{15}{16}$	$1\frac{1}{2}$	$2\frac{1}{4}$	$2\frac{5}{16}$	$1\frac{1}{2}$
D D	$1\frac{1}{4}$ "	500	75–135	$4\frac{5}{16}$	$3\frac{5}{8}$	$1\frac{13}{16}$	$2\frac{1}{4}$	$3\frac{15}{16}$	$2\frac{1}{4}$	$3\frac{15}{16}$	$1\frac{1}{2}$	$2\frac{1}{4}$	$2\frac{5}{16}$	$1\frac{1}{2}$
E	$1\frac{1}{2}$ "	700	100–180	$4\frac{7}{8}$	$4\frac{1}{4}$	2	$2\frac{5}{8}$	$4\frac{1}{2}$	$2\frac{5}{8}$	$4\frac{1}{2}$	$1\frac{9}{16}$	$2\frac{1}{4}$	$3\frac{1}{2}$	2
E E	$1\frac{1}{2}$ "	900	150–225	$5\frac{7}{16}$	$4\frac{1}{4}$	$2\frac{1}{16}$	$3\frac{1}{8}$	$4\frac{1}{2}$	$2\frac{15}{16}$	$4\frac{3}{4}$	$1\frac{3}{4}$	$2\frac{1}{4}$	$3\frac{1}{2}$	2
F	2 "	1100	160–320	$5\frac{7}{8}$	5	$2\frac{3}{8}$	$3\frac{7}{16}$	5	$3\frac{11}{16}$	$5\frac{3}{8}$	$2\frac{1}{2}$	$2\frac{1}{4}$	$4\frac{1}{4}$	$2\frac{1}{2}$
F F	2 "	1400	200–400	$6\frac{3}{8}$	$5\frac{3}{8}$	$2\frac{9}{16}$	$4\frac{1}{4}$	$5\frac{7}{8}$	4	$5\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{4}$	$4\frac{1}{2}$	$2\frac{1}{2}$
G	$2\frac{1}{2}$ "	1800	300–500	$8\frac{5}{16}$	$5\frac{7}{8}$	$3\frac{1}{8}$	$4\frac{11}{16}$	$6\frac{1}{4}$	$4\frac{1}{2}$	$6\frac{1}{2}$	$3\frac{1}{3}$	$2\frac{1}{4}$	$4\frac{1}{4}$	3

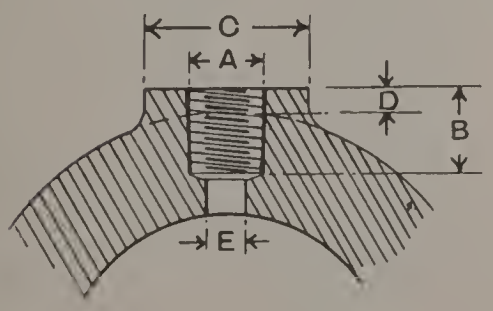


Plain Oil Cups.

The dimension G is threaded as iron pipe of the size given.

A	B	C	D	E	F	G	H	I	J	K
[illegible]	[illegible]	[illegible]	$\frac{3}{8}$	$\frac{1}{2}$	[illegible]	$\frac{1}{8}$	$\frac{1}{1}$	$\frac{3}{16}$	1	$\frac{1}{8}$
[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	$\frac{1}{8}$	$\frac{1}{1}$	$\frac{3}{16}$	$1\frac{1}{4}$	$\frac{3}{16}$
1	[illegible]	$1\frac{1}{8}$	[illegible]	[illegible]	[illegible]	$\frac{1}{1}$	$\frac{3}{8}$	$\frac{3}{16}$	$1\frac{1}{2}$	$\frac{3}{16}$
$1\frac{1}{8}$	[illegible]	$1\frac{3}{8}$	$\frac{1}{2}$	[illegible]	[illegible]	$\frac{1}{1}$	$\frac{1}{2}$	$\frac{1}{1}$	$1\frac{1}{2}$	$\frac{3}{16}$
$1\frac{1}{4}$	1	$1\frac{3}{8}$	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{7}{8}$	$\frac{1}{1}$	$\frac{1}{2}$	$\frac{1}{4}$	$1\frac{3}{4}$	$\frac{1}{4}$
$1\frac{1}{2}$	$1\frac{1}{4}$	$1\frac{3}{8}$	$\frac{5}{8}$	$\frac{7}{8}$	1	$\frac{3}{8}$	$\frac{5}{8}$	$\frac{1}{1}$	2	$\frac{1}{4}$
$1\frac{3}{4}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$\frac{5}{8}$	$\frac{7}{8}$	$1\frac{1}{8}$	$\frac{3}{8}$	$\frac{5}{8}$	$\frac{1}{4}$	$2\frac{1}{2}$	$\frac{1}{4}$
2	$1\frac{3}{4}$	$2\frac{1}{4}$	$\frac{3}{4}$	1	$1\frac{1}{4}$	$\frac{3}{8}$	$\frac{5}{8}$	$\frac{3}{8}$	$2\frac{7}{8}$	$\frac{1}{4}$
$2\frac{1}{4}$	$1\frac{7}{8}$	$2\frac{1}{2}$	$\frac{3}{4}$	$1\frac{1}{8}$	$1\frac{3}{8}$	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{3}{8}$	$3\frac{1}{2}$	$\frac{1}{4}$
$2\frac{1}{4}$	$2\frac{1}{4}$	$2\frac{7}{8}$	$\frac{3}{4}$	$1\frac{1}{4}$	$1\frac{1}{2}$	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{3}{8}$	$4\frac{1}{4}$	$\frac{1}{4}$
3	$2\frac{1}{2}$	$3\frac{1}{2}$	$\frac{3}{4}$	$1\frac{1}{4}$	$1\frac{1}{2}$	$\frac{3}{4}$	1	$\frac{3}{8}$	$4\frac{3}{4}$	$\frac{3}{8}$

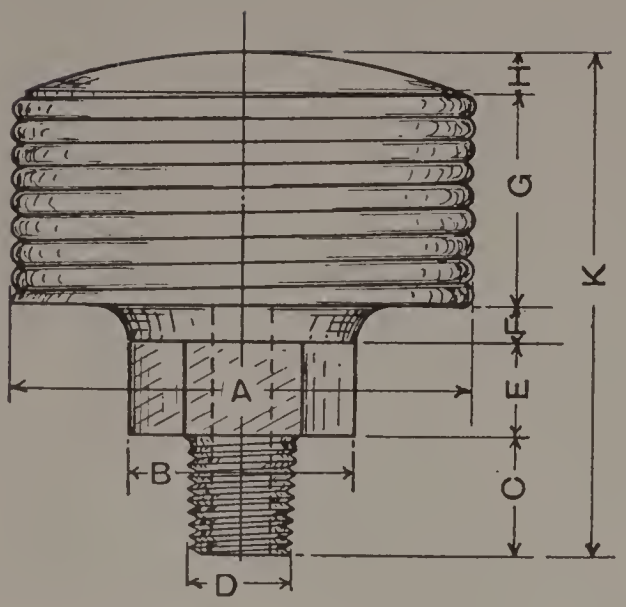
Taped Hole for Oil Cup.



Find A from table of pipe size and make C=2A.

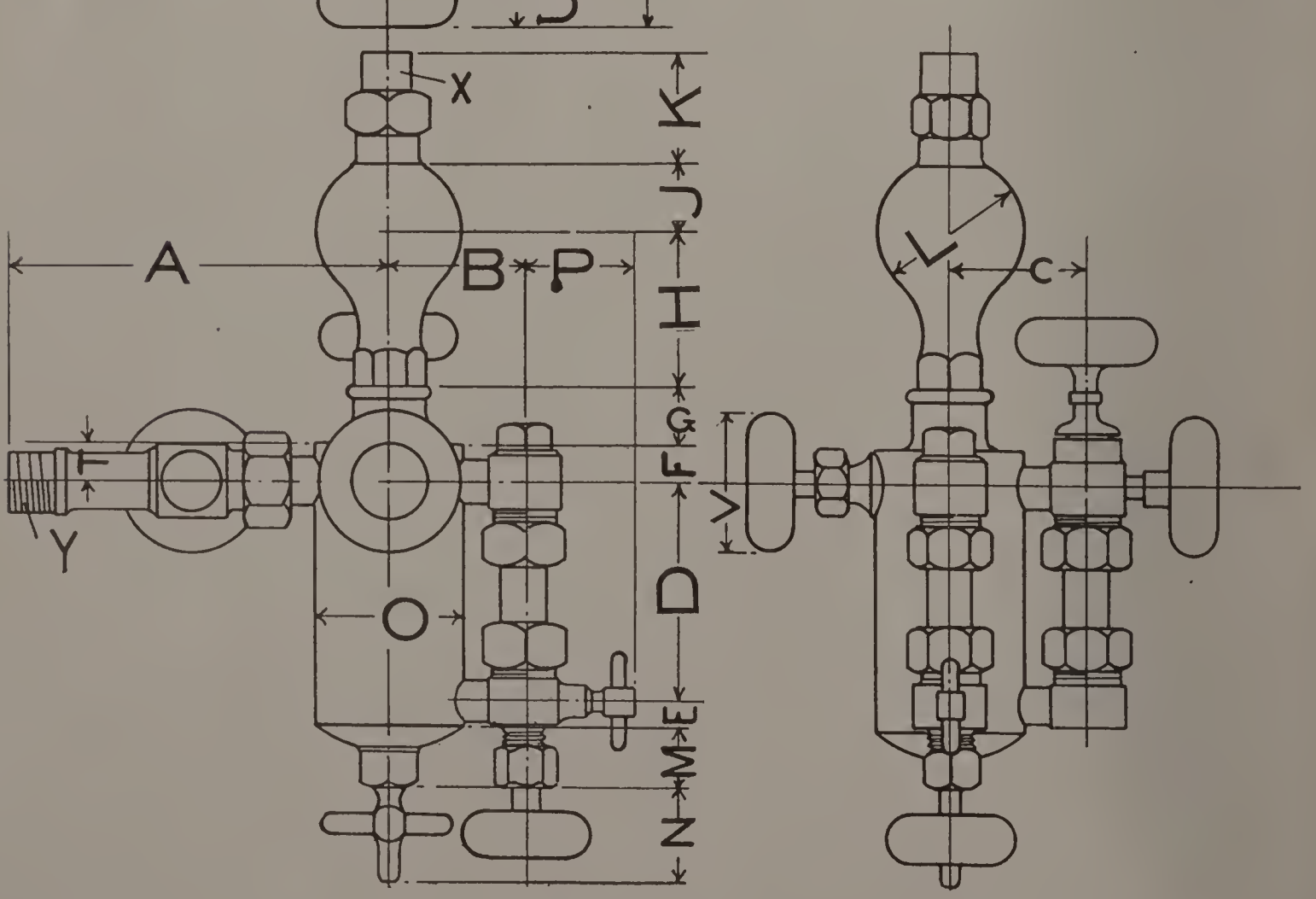
Make D =1-16″ to ¼″.

B=length of perfect thread on pipe.



Dimensions of Bonanza Grease Cup.

No.	2	3	4	5	6	7
A	$\frac{3}{4}$	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{15}{16}$	$2\frac{5}{16}$	$2\frac{5}{8}$
B	$\frac{1}{2}$	$\frac{15}{16}$	1	1	$1\frac{1}{4}$	$1\frac{1}{4}$
C	$\frac{3}{8}$	$\frac{9}{16}$	$\frac{9}{16}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{5}{8}$
D	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{5}{8}$
E	$\frac{5}{16}$	$\frac{7}{16}$	$\frac{7}{16}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{1}{2}$
F	$\frac{1}{16}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{3}{16}$	$\frac{1}{4}$
G	$\frac{3}{4}$	$\frac{7}{8}$	$\frac{15}{16}$	1	$1\frac{1}{16}$	$1\frac{1}{8}$
H	Flat	$\frac{1}{16}$	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{1}{4}$	$\frac{3}{8}$
K	$1\frac{1}{2}$	$2\frac{1}{16}$	$2\frac{1}{8}$	$2\frac{7}{16}$	$2\frac{5}{8}$	$2\frac{7}{8}$
Pipe Tap	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{3}{8}$
Size of Shaft		1 to $1\frac{3}{4}$	2 to $2\frac{3}{4}$	3 to $3\frac{3}{4}$	4 to $4\frac{3}{4}$	5 to 6



Sight Feed Lubricator,

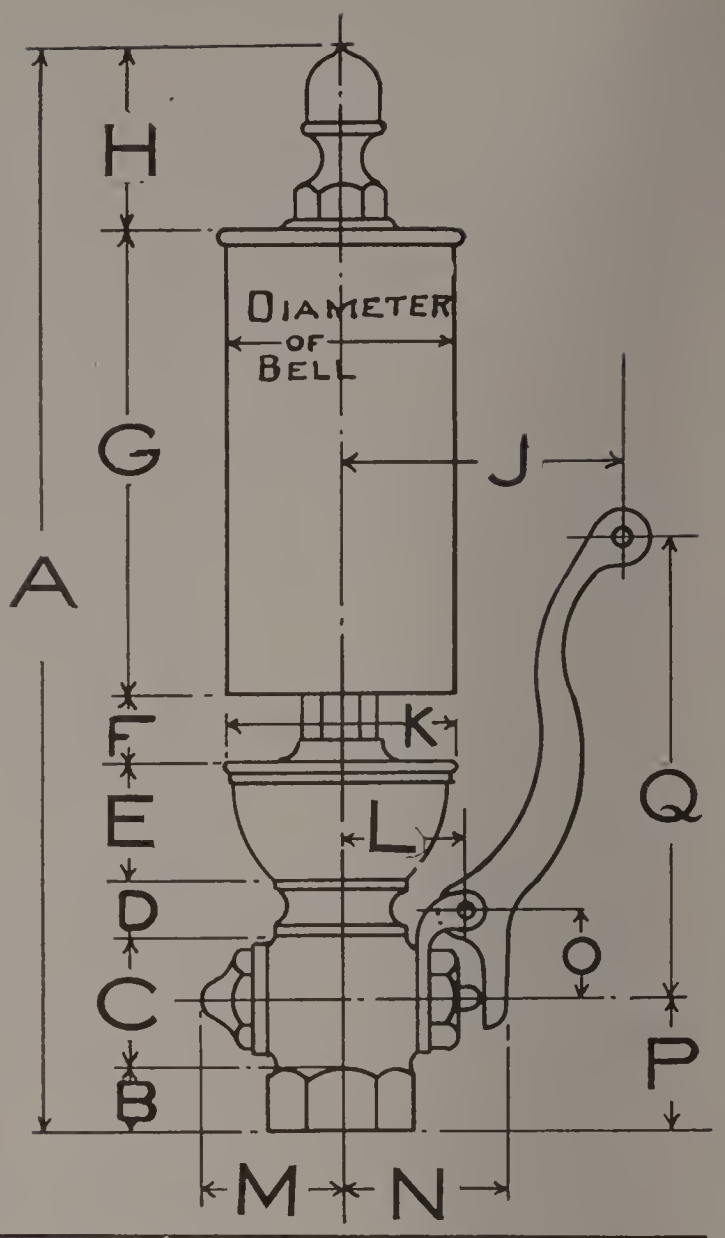
Dimensions of Sight Feed Lubricators.

	⅓ Pint	½ Pint	1 Pint	1 Quart	½ Gal.	1 Gal.
A	$5\frac{1}{8}$	$5\frac{1}{8}$	$5\frac{1}{2}$	$5\frac{7}{8}$	$7\frac{15}{16}$	$8\frac{3}{16}$
B	$1\frac{3}{4}$	$1\frac{7}{8}$	$2\frac{1}{8}$	$2\frac{5}{16}$	$3\frac{1}{16}$	$3\frac{5}{16}$
C	$1\frac{3}{4}$	$1\frac{3}{4}$	2	$2\frac{1}{2}$	$3\frac{1}{16}$	$3\frac{5}{16}$
D	$2\frac{7}{8}$	4	4	$3\frac{7}{8}$	$4\frac{1}{8}$	$4\frac{1}{1}$
E	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{5}{8}$
F	$\frac{1}{2}$	$\frac{1}{2}$	$1\frac{1}{2}$	2	$3\frac{1}{4}$	$4\frac{1}{16}$
G	$\frac{39}{64}$	$\frac{39}{64}$	$\frac{29}{32}$	$\frac{29}{32}$	$1\frac{5}{32}$	$1\frac{5}{16}$
H	$2\frac{3}{16}$	$2\frac{3}{16}$	$2\frac{1}{2}$	$2\frac{13}{16}$	$4\frac{1}{16}$	$4\frac{1}{16}$
J	$\frac{29}{32}$	$\frac{29}{32}$	$1\frac{5}{32}$	$1\frac{5}{16}$	$1\frac{3}{4}$	$1\frac{3}{4}$
K	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{3}{4}$	$1\frac{3}{4}$
L	$2\frac{1}{16}$	$2\frac{1}{16}$	$2\frac{1}{2}$	$2\frac{13}{16}$	$3\frac{3}{4}$	$3\frac{3}{4}$
M	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$1\frac{1}{4}$	$1\frac{11}{16}$	2
N	$1\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{1}{4}$
O	$2\frac{1}{8}$	$2\frac{1}{8}$	$2\frac{21}{32}$	$3\frac{9}{16}$	$4\frac{7}{16}$	5
P	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$
R	$2\frac{7}{8}$	$3\frac{1}{2}$	$3\frac{3}{4}$	$4\frac{5}{16}$	$4\frac{11}{16}$	5
S	$3\frac{5}{8}$	$3\frac{5}{8}$	$3\frac{5}{8}$	$3\frac{5}{8}$	$3\frac{5}{8}$	$3\frac{5}{8}$
T	$\frac{1}{2}$	$1\frac{3}{4}$	$1\frac{7}{8}$	$3\frac{3}{16}$	$3\frac{1}{2}$	$4\frac{7}{16}$
Y	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{3}{4}$
X	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$

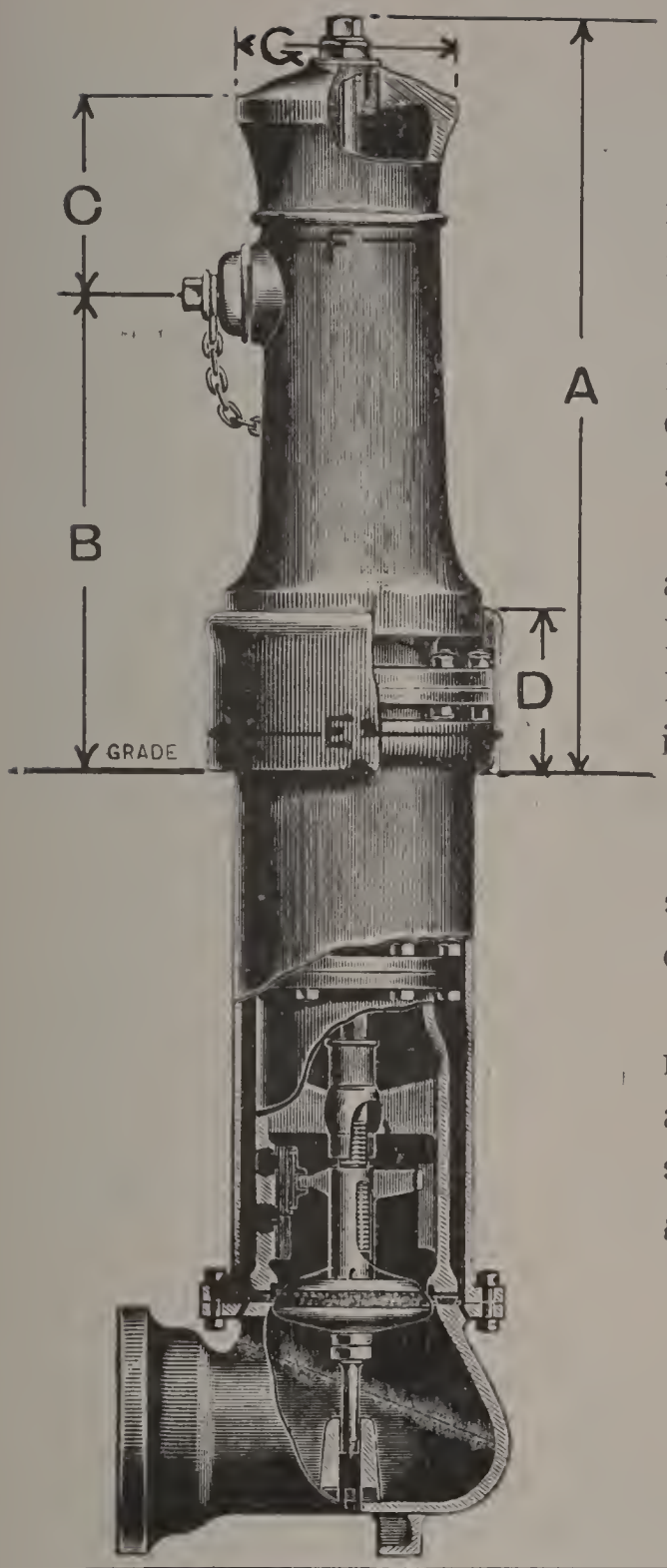
MEMORANDUM.

Whistles.

In some of the larger sizes there is a recess between B and C as at D. The amount for C should be equally devided each side of the center line found by using P from the bottom. The distance across corners of the nut B can be taken equal to twice the outside diameter of the pipe used.



Diam. Bell	1	$1\frac{1}{4}$	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3	$3\frac{1}{2}$	4	5	6	8
Size Pipe	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{3}{4}$	$\frac{3}{4}$	1	1	$1\frac{1}{4}$	$1\frac{1}{2}$	2	$2\frac{1}{2}$
A	6	7	8	$10\frac{3}{8}$	$11\frac{3}{4}$	13	$13\frac{1}{4}$	$13\frac{5}{8}$	$17\frac{5}{8}$	$19\frac{3}{4}$	$27\frac{1}{2}$
B	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	$1\frac{3}{8}$
C	1	$1\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{3}{4}$	2	$2\frac{1}{2}$	3
D				$\frac{1}{2}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	1
E	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{7}{8}$	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	$1\frac{7}{8}$	2	$2\frac{3}{4}$
F	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	1	1	$2\frac{1}{4}$
G	$2\frac{1}{2}$	3	$3\frac{1}{4}$	4	$4\frac{1}{2}$	5	$5\frac{3}{4}$	$6\frac{1}{2}$	8	$9\frac{1}{2}$	14
H	1	1	$1\frac{1}{2}$	$1\frac{7}{8}$	2	$2\frac{1}{8}$	$2\frac{1}{4}$	$2\frac{1}{4}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$3\frac{1}{8}$
J	1	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3	$3\frac{1}{2}$	$3\frac{1}{2}$	4	5	$5\frac{1}{2}$	7
K	$1\frac{1}{4}$	$1\frac{1}{2}$	2	$2\frac{3}{8}$	$2\frac{1}{2}$	$3\frac{3}{8}$	4	$4\frac{1}{2}$	$5\frac{1}{2}$	$6\frac{1}{2}$	$8\frac{1}{2}$
L	$\frac{7}{8}$	1	$1\frac{1}{4}$	$1\frac{3}{4}$	$1\frac{7}{8}$	2	$2\frac{1}{4}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{7}{8}$	$3\frac{1}{2}$
M	1	$1\frac{1}{4}$	$1\frac{3}{8}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{3}{4}$	$2\frac{1}{4}$	$2\frac{3}{8}$	$2\frac{1}{2}$	3
N	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{3}{4}$	2	2	$2\frac{1}{2}$	$2\frac{3}{4}$	$3\frac{1}{4}$	$3\frac{1}{2}$	$3\frac{7}{8}$	$4\frac{1}{4}$
O	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{3}{4}$	1	1	1	$1\frac{1}{2}$
P	$\frac{7}{8}$	$1\frac{1}{8}$	$1\frac{1}{2}$	$1\frac{3}{4}$	$1\frac{7}{8}$	2	2	$2\frac{1}{8}$	$2\frac{1}{4}$	$2\frac{1}{2}$	$3\frac{1}{4}$
Q	2	$2\frac{1}{4}$	$3\frac{1}{2}$	$4\frac{1}{2}$	5	6	$6\frac{1}{2}$	7	8	$8\frac{1}{2}$	10



Fire Hydrants.

The ordinary fire hydrants differ somewhat as to shape and more as to manner of operating, depending on the ideas of the maker.

The different manufacturers claim points of superiority in their particular design, which must be decided by the person who is to purchase the hydrant.

For simplicity of form, we have taken an illustration from the style made by the Norwood Engineering Co., Florence. Mass., who have kindly supplied the leading dimensions in the following table.

Two features should always be considered in selecting a fire hydrant, accessibility to all parts for repairs and liability of freezing.

The threads for hose connections are not all alike for the same size hydrants as made by the different manufacturers, so in ordering, alway follow instructions given in the catalog of the firm selected.

Some General Dimensions are here given.

Size of Hyd.	Diameter Pipe Connection.	Dia. of Valve Opening	No. Outlet	A	B	C	D	E	F	G
3 "	4 "	$3\frac{1}{4}$ "	1	No. 3 Hydrants made by the N. E. CO.						
$4\frac{1}{2}$"	4 or 6"	$4\frac{1}{2}$ "	1 2 3	$31\frac{1}{2}$"	$19\frac{1}{2}$"	8 "	$7\frac{1}{2}$"	$10\frac{7}{8}$"	$6\frac{5}{16}$"	$8\frac{1}{16}$"
5 "	6 "	$5\frac{1}{2}$ "	2 3 4	33 "	$20\frac{1}{2}$"	$8\frac{1}{2}$"	$7\frac{1}{2}$"	12 "	7 "	$8\frac{3}{4}$"
6 "	6 or 8"	$6\frac{1}{2}$ "	2 3 4	$34\frac{1}{2}$"	$21\frac{1}{2}$"	9 "	$7\frac{1}{2}$"	13 "	$7\frac{3}{4}$"	$9\frac{1}{2}$"

Length from grade to bottom of pipe is made in 3, $3\frac{1}{2}$, 4, $4\frac{1}{2}$, 5, 6, 7, $7\frac{1}{2}$, 8, $8\frac{1}{2}$ and 9 ft. for all sizes. Openings are set at right angles with each other.

HOSE.

Rubber hose is made in sizes varying from ½ to 4″ inclusive in two. three and four ply, Steam hose in sizes ½ to 3″ inclusive in three four, five and six ply. Cotton hose, rubber lined in sizes ½ to 2½ inclusive. Hose couplings may be secured with iron pipe thread or if they have regular hose thread, a hose nipple may be secured with either male or female threads

Several sizes of hose reducers may be secured as well as hose bushings and strainers.

Steam hose couplings are longer and have a much better joint than the ordinary hose coupling.

Metalic Tubing is on the market. the sizes here shown, which is quite servicable for gases and fluids, even at rather high temperatures.

Fire Streams

Size of Nozzles	1 Inch				1⅛ Inches				1¼ Inches				1⅜ Inches			
Pressure at Nozzle	40	60	80	100	40	60	80	100	40	60	80	100	40	60	80	100
Pressure at Pump or Hydrant with 100 ft. 2½″ Rubber Hose	48	73	97	121	54	81	108	135	61	192	123	154	71	107	144	180
Gallons per min.	155	189	219	245	196	240	277	310	242	297	342	382	293	358	413	462
Horzontal Distance Thrown	109	142	861	186	113	148	175	193	118	156	186	207	124	166	200	224
Vertical Distance Thrown	79	108	13.	148	81	112	137	157	82	115	142	164	85	118	146	169

MEMORANDUM

CHAPTER. V.

MISCELLANEOUS

A few notes on steam heating may not be amiss in this volume, for while the book is intented to give sizes and proportions of pipe fittings and valves, yet anything to assist the draftsman in the design of heating plants will be in order.

Various formulas and notes have been laid out for the direction of the designer and no doubt much of it is very valuable matter, so what is given here will only be a small amount that has come under the observation and experience of the author.

In laying out heating systems, small pipes are found much more effective than large ones.

The radiating surface of various sizes of pipes is shown here.

1½″	pipe it will require				2	linear	feet
2″	"	"	"	"	1½	"	"
2½″	"	"	"	"	16	Inches	
3″	"	"	"	"	13	"	"
3½″	"	"	"	"	11	"	"
4″	"	"	"	"	10	"	"
4½″	"	"	"	"	9	"	"
5″	"	"	"	"	8	"	"

To give a square foot of radiating surface from 1½″ pipe it will require 2½″ linear feet, and for other sizes see list at left.

The following table gives more additional values.

HEATING SURFACE.

STANDARD WEIGHT PIPE.			EXTRA STRONG PIPE.			DBLE. EX. STRONG PIPE.		
Length of Pipe in Ft. per Sq. Ft. of			Length of Pipe in Ft. per Sq. Ft. of			Length of Pipe in Ft. per Sq. Ft. of		
Size.	External Surface.	Internal Surface.	Size	External Surface.	Internal Surface.	Size.	External Surface.	Internal Surface.
⅛	9.44	14.2	⅛	9.44	18.63	½	4.55	15.67
¼	7.07	10.5	¼	7.07	12.99	¾	3.64	9.05
⅜	5.66	7.76	⅜	5.66	9.07	1	2.90	6.51
½	4.55	6.15	½	4.55	7.05	1¼	2.30	4.32
¾	3.64	4.64	¾	3.64	5.11	1½	2.01	3.51
1	2.90	3.66	1	2.90	4.02	2	1.61	2.56
1¼	2.30	2.77	1¼	2.30	3.00	2½	1.33	2.18
1½	2.01	2.38	1½	2.01	2.56	3	1.09	1.67
2	1.61	1.85	2	1.61	1.97	3½	955	1.41
2½	1.33	1.55	2½	1.33	1.65	4	.849	1.22
3	1.09	1.25	3	1.09	1.33	4½	764	1.07
3½	.955	1.08	3½	.955	1.14	5	.687	.94
4	.849	.949	4	.849	1.00	6	.577	.78
4½	.764	.848	4½	.764	.893	7	.501	.65
5	.687	.757	5	.687	.793	8	.443	.55
6	.577	.630	6	.577	.664	....	....	....
7	.501	.544	7	.501	.598	....	....	...
8	.443	.478	8	.443	.502	....	....	...
9	.397	.427	9	.397	.443	...	...	...
10	.355	.381	10	.355	.399	.. .	....	....
11	.325	.348	....	....	....	....	....	....
12	.299	.319	12	.299	.325	....	....	....

Pipe Coils for Heating.

In radiators one sq. ft. to every 80 cu. ft. of space to be had is a fair average and one horse power in a boiler is generally sufficient, for a temperature of 70° Farh. and it is also said that on a sq. ft. of heating surface in a boiler to 100 in a church and 50 cu. ft. in dwelling is sufficient,

It is necessary to estimate on the surface of glass, walls and ceilings and about this proportion can be assumed with safety.

One square foot of radiating surface for every 6 square feet of glass, or 100 square feet of wall.

One square foot of radiating surface for every square foot of space.

One square foot of radiating surface with steam at 212° has been found to heat 100 cubic feet in an hour from 0 to 100.

50 to 100% more heating surface required if heating is by indirect radiation is demanded for glass in windows than for the same surface in brick walls.

A simple rule to find the radiating surface to heat a room. a hall or a building would be to add together the square foot of glass in windows the cubic feet of air required to be changed per minuet and the difference of required temperature of room and than by the external air. Devide the product by the difference in the temperature of steam in room.

In reference to steam mains, it is well to allow ½ square inch of main to every 100 sq. ft. radiating surface carried on the main.

The main pipe to be used to the various radiators will be 1½" for 60 to 75 feet of surface, 2" for 75 to 100, 2½" for 100 square feet and upwards, reducing as the radiators are passed.

Making Pipe Coils for Heating Purposes.

As a general rule, coils are made as long as the room or wall space where they are intented to be placed will allow them to be, and the first thing is to find the length.

Since allowance must be made for expansions, an upright portion is made as shown in Fig. 1 and if the total length of the coil is not more than 12 feet, then pipe A need not be more than 18". The longer the coil, the greater must be A in length. Six pipes to a coil is a very common number and 1¼" is generally used. (See A Chapter on Pipe for expansion of pipe and previous pages for heating surface of pipe.)

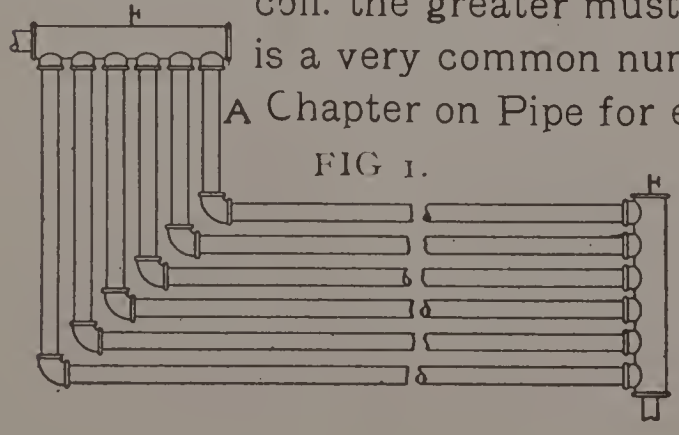


FIG 1.

In Fig. 2 is shown a return bend coil and in Fig. 3 a double return, both affording ample expansion.

Often in making up a heating coil

some of the fittings will have to be made with right and left hand threads so that the coil may be put together readily.

Fig. 3 is much better for hot water heating than Fig. 2 and the vents shoulds be placed as shown.

The desire to have the supply and return at the same end may be accomplished by arranging as in Fig. 4 using branch tees or manifolds at one end and right and left hand fittings at the other.

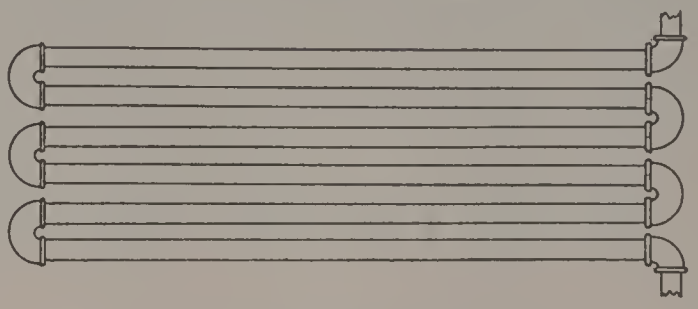


FIG. 2,

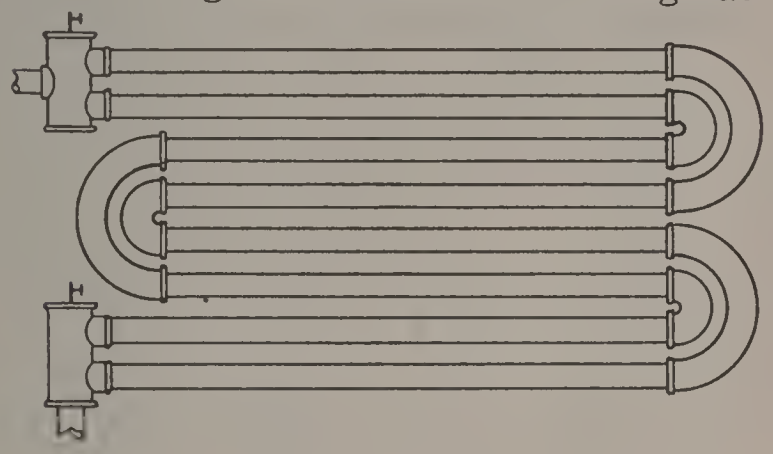


FIG. 3,

This arrangement is good for both steam and hot water heating with the vents as shown.

The vents are usually threaded for ¼″ pipe and fitted with air cocks. The drain or return pipe is usually one size smaller than the inlet.

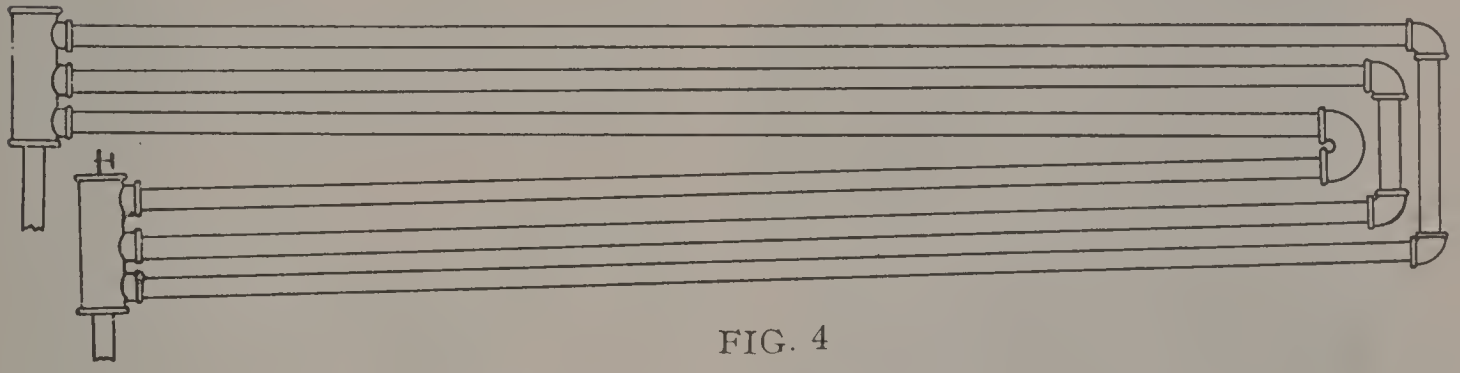


FIG. 4

Cast Iron Radiators.

In very many cases of steam and hot water heating, the cast iron radiator is used instead of pipe coils.

The height of the radiators vary from 15 to 48″ and hence can be secured to fit almost any location in the building, the more common being about 32″.

Radiators to fit curved or angular places may be secured if exact radius or angle of base board at the floor where the radiator is to be placed is given.

Owing to the difference in heights of supply and return end tappings from the floor, a sketch should be sent.

The following illustration and tables are taken from the catalog of The American Radiator Co.,

Tapping List of American Radiators

Steam

ONE-PIPE WORK

Radiators containing 24 square feet and under	1 inch
Above 24, but not exceeding 60 feet	1¼ inch
Above 60, but not exceeding 100 feet	1½ inch
Above 100 square feet	2 inch

TWO-PIPE WORK

Radiators containing 48 square feet and under	1 x ¾ inch
Above 48, but not exceeding 96 feet	1¼ x 1 inch
Above 96 square feet	1½ x 1¼ inch

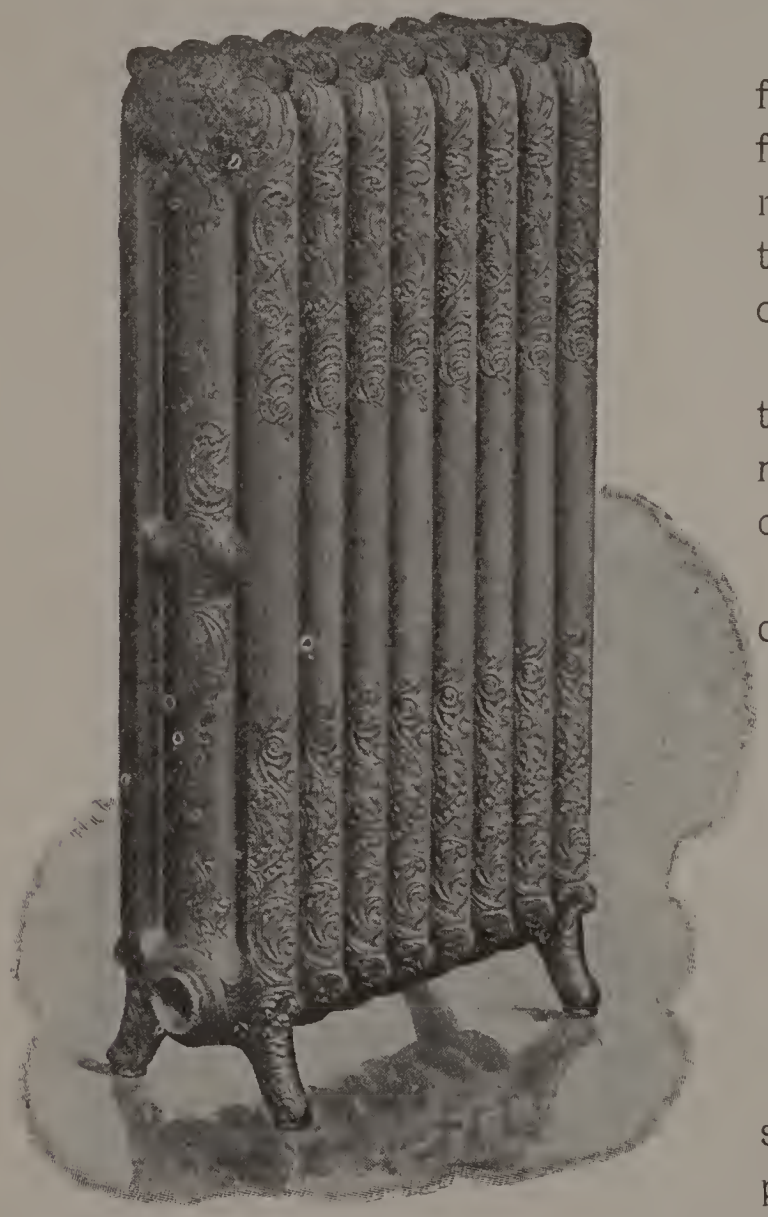
Hot Water

TAPPED FOR SUPPLY AND RETURN

Radiators containing 40 square feet and under	1 inch
Above 40, but not exceeding 72 square feet	1¼ inch.
Above 72 square feet	1½ inch

All openings will have right-hand threads, unless otherwise ordered.
All air-valve tappings are regularly made ⅛ inch.

No. of Sections	*Length 2½ in. per Sec.	Heating Surface—Square Feet. 44 in. Height. 6 sq. ft. per Sec.	38-in. Height. 5 sq. ft. per Sec.	32-in. Height. 4½ sq. ft. per Sec.	26-in. Height. 3¾ sq. ft. per Sec.	22 in. Height. 3 sq. ft. per Sec.	18-in. Height. 2¼ sq. ft. per Sec.
2	5	12	10	9	7½	6	4½
3	7½	18	15	13½	11¼	9	6¾
4	10	24	20	18	15	12	9
5	12½	30	25	22½	18¾	15	11¼
6	15	36	30	27	22½	18	13½
7	17½	42	35	31½	26¼	21	15¾
8	20	48	40	36	30	24	18
9	22½	54	45	40½	33¾	27	20¼
10	25	60	50	45	37½	30	22½



Chicago. but are only a few of the many given.

The above radiators are tapped 2″ and bushed as per the fo llowing tables which gives openings required for different amounts of heating surface.

The height of inlet and outlet from the floor is 4½″ for water: 4″ for single steam 4½ supply and 4″ return, for double-pipe steam systems. This variation is often accomplished by eccentric bushings.

In some cases a top feed and bottom return may be desired and this may be secured in certain patterns of water radiators.

In estimating the length of a radiators, allow ½″ for each bushing.

Table of Mains and Branches

Main			Branch						
1	in.	will supply	2	.....				¾	in.
1¼	in.	"	2	.....				1	in.
1½	in.	"	2	.....				1¼	in.
2	in.	"	2	.....				1½	in.
2½	in.	"	2	1½	in. and 1	1¼	in., or 1 2	in. and 1 1¼	in.
3	in.	"	1	2½	in. and 1 2	in., or 2 2	in. and 1 1½		in.
3½	in.	"	2	2½	in. or 1 3	in., and 1 2	in. or 3 2		in.
4	in.	"	1	3½	in. and 1 2½	in., or 2 3	in. and 4 2		in.
4½	in.	"	1	3½	in. and 1 3	in., or 1 4	in. and 1 2½		in.
5	in.	"	1	4	in. and 1 3	in., or 1 4½	in. and 1 2½		in.
6	in.	"	2	4	in. and 1 3	in., or 4 3	in. or 10 2		in.
7	in.	"	1	6	in. and 1 4	in., or 3 4	in. and 1 2		in.
8	in.	"	2	6	in. and 1 5	in., or 5 4	in. and 2 2		in.

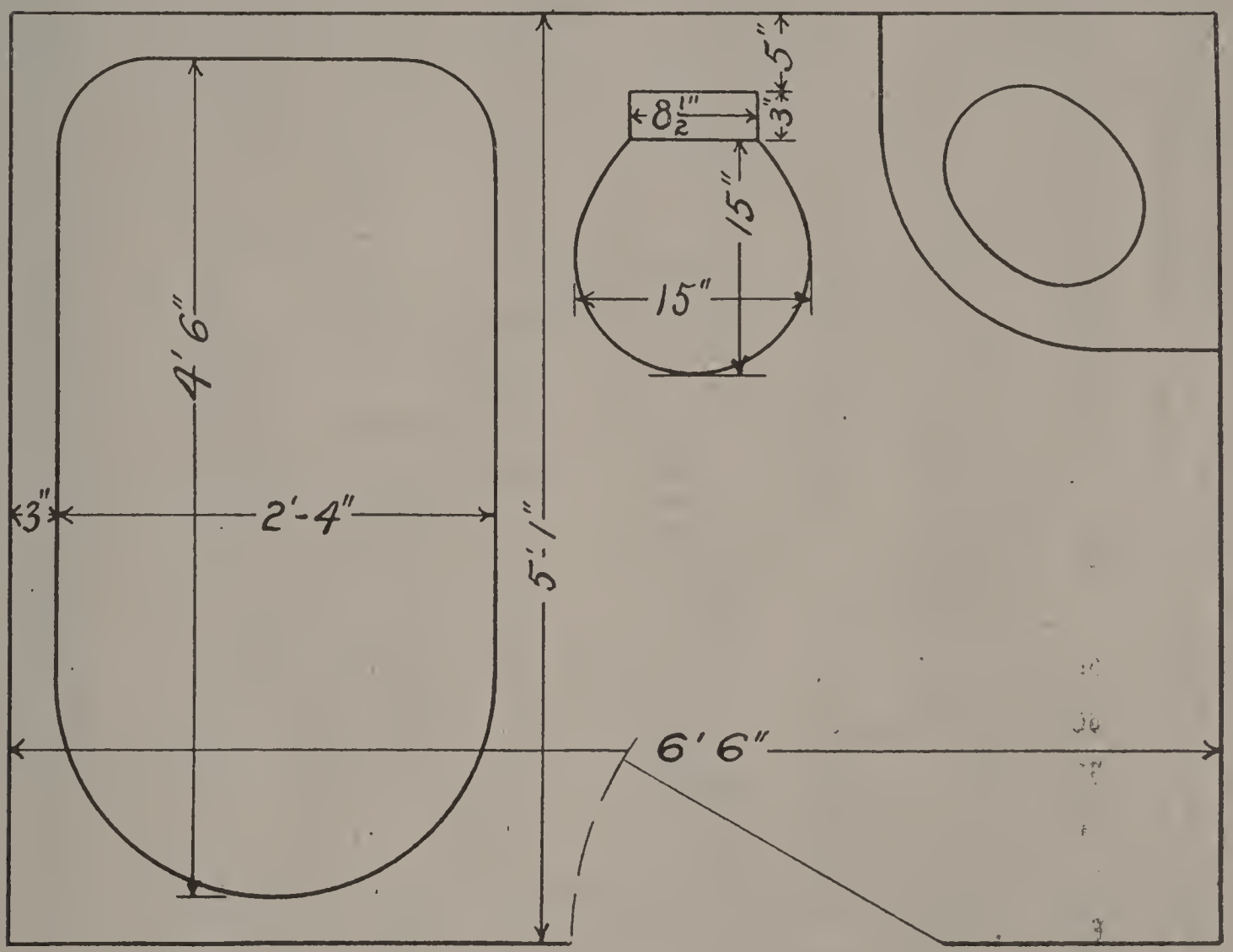
The above table will give the size of branches that can be supplied by any main.

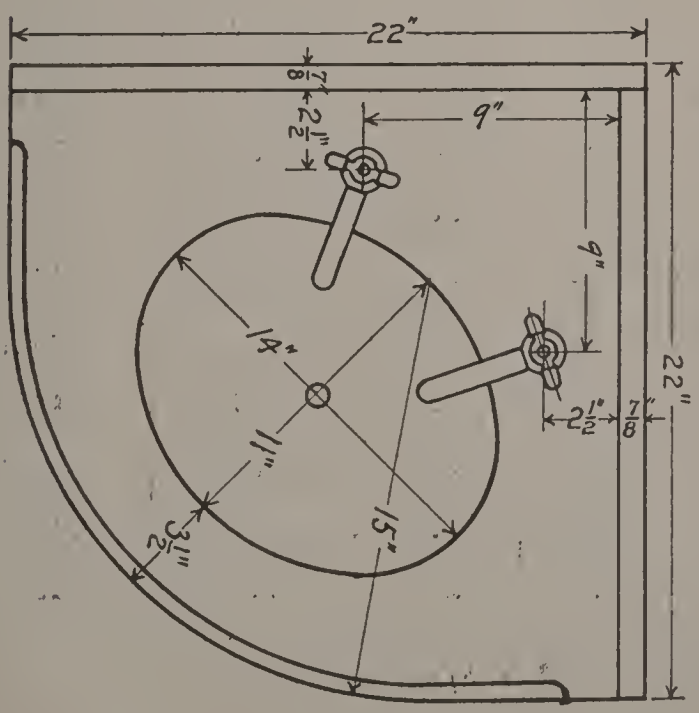
Bath Room Fixtures.

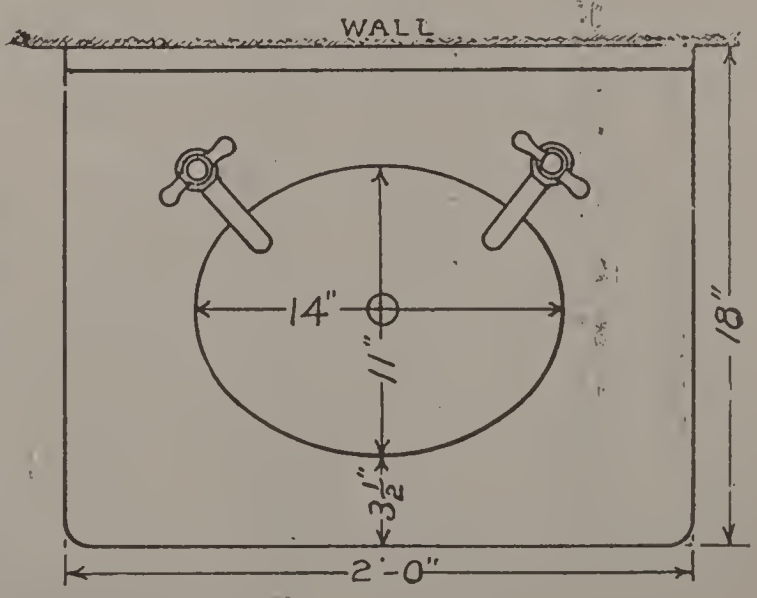
The illustration shows out line of a bath tub. seat and bowln in a small both room, the dimensions of the wash stand being shown in the following sketch.

For a side basin use dimensions as show. Tubs should be set with at least 3″ clearance at the ends and backs and if room permit the tub should be 5′ 0″ long. that being a very convenient size.

Bowls should be set 30″ from the floor.







PROPERTIES OF SATURATED STEAM.

Absolute Pressure.	Gage Pressure.	Temperature F.	Weight in Pounds per Cubic Foot of Steam.	Volume in Cubic Feet of One Pound of Steam.	Total Heat above 32° F.		Latent Heat, Heat Units.
					In the Water, Heat Units.	In the Steam, Heat Units.	
1	-27.9	102.1	.003	334.23	70.09	1113.1	1043.0
5	-19.7	162.3	.014	72.50	130.7	1131.4	1000.7
10	-9.6	193.2	.026	37.80	161.9	1140.9	979.0
14.7	0.	212.0	.038	26.36	180.9	1146.6	965.7
15	.3	213.0	.039	25.87	181.9	1146.9	965.0
20	5.3	227.9	.050	19.72	197.0	1151.5	954.4
25	10.3	240.0	.063	15.99	209.3	1155.1	945.8
30	15.3	250.2	.074	13.48	219.7	1158.3	938.9
35	20.3	259.2	.086	11.66	228.8	1161.0	932.2
40	25.3	267.1	.097	10.28	236.9	1163.4	926.5
45	30.3	274.3	.109	9.21	244.3	1165.6	921.3
50	35.3	280.9	.120	8.34	251.0	1167.6	916.6
55	40.3	286.9	.131	7.63	257.2	1169.4	912.3
60	45.3	292.5	.142	7.03	262.9	1171.2	908.2
65	50.3	297.8	.153	6.53	268.3	1172.8	904.5
70	55.3	302.7	.164	6.09	273.4	1174.3	900.9
75	60.3	307.4	.175	5.71	278.2	1175.7	897.5
80	65.3	311.8	.186	5.37	282.7	1177.0	894.3
85	70.3	316.0	.197	5.07	287.0	1178.3	891.3
90	75.3	320.0	.208	4.81	291.2	1179.6	888.4
95	80.3	323.9	.219	4.57	295.1	1180.7	885.6
100	85.3	327.6	.230	4.36	298.9	1181.8	882.9
110	95.3	334.5	.251	3.98	306.1	1184.0	877.9
120	105.3	341.0	.272	3.67	312.8	1185.9	873.2
130	115.3	347.1	.294	3.41	319.1	1187.8	868.7
140	125.3	352.8	.315	3.18	325.0	1189.5	864.6
150	135.3	358.2	.336	2.98	330.6	1191.2	860.6
160	145.3	363.3	.357	2.80	335.9	1192.7	856.9

From Supplement to *Machinery*.

PROPERTIES OF SATURATED STEAM (Continued).

Absolute Pressure.	Gage Pressure.	Temperature F.	Weight In Pounds per Cubic Foot of Steam.	Volume In Cubic Feet of One Pound of Steam.	Total Heat above 32° F.		Latent Heat, Heat Units.
					In the Water, Heat Units.	In the Steam, Heat Units.	
170	155.3	368.2	.378	2.65	340.9	1194.2	853.3
180	165.3	372.8	.398	2.51	345.8	1195.7	849.9
190	175.3	377.3	.419	2.39	350.4	1197.0	846.6
200	185.3	381.6	.440	2.27	354.9	1198.3	843.4
210	195.3	385.7	.461	2.17	359.2	1199.6	840.4
220	205.3	389.7	.485	2.06	362.2	1200.8	838.6
230	215.3	393.6	.506	1.98	366.2	1202.0	835.8
240	225.3	397.3	.527	1.90	370.0	1203.1	833.1
250	235.3	400.9	.548	1.83	373.8	1204.2	830.5
260	245.3	404.4	.569	1.76	377.4	1205.3	827.9
270	255.3	407.8	.589	1.70	380.9	1206.3	825.4
280	265.3	411.0	.610	1.64	384.3	1207.3	823.0
290	275.3	414.2	.630	1.585	387.7	1208.3	820.6
300	285.3	417.4	.651	1.535	390.9	1209.2	818.3
350	335.3	432.0	.755	1.325	406.3	1213.7	807.5
400	385.3	444.9	.857	1.167	419.8	1217.7	797.9
450	435.3	456.6	.959	1.042	432.2	1221.3	789.1
500	485.3	467.4	1.062	.942	443.5	1224.5	781.0
550	535.3	477.5	1.164	.859	454.1	1227.6	773.5
600	585.3	486.9	1.266	.790	464.2	1230.5	766.3
650	635.3	495.7	1.368	.731	473.6	1233.2	759.6
700	685.3	504.1	1.470	.680	482.4	1235.7	753.3
750	735.3	512.1	1.572	.636	490.9	1238.0	747.2
300	785.3	519.6	1.674	.597	498.9	1240.3	741.4
850	835.3	526.8	1.776	.563	506.7	1242.5	735.8
900	885.3	533.7	1.878	.532	514.0	1244.7	730.6
950	935.3	540.3	1 980	.505	521.3	1246.7	725.4
1000	985.3	546.8	2.082	.480	528.3	1248.7	720.3

From Supplement to *Machinery*.

Weight of Water per Cubic Foot and Heat Units in Water between 32° and 212° F.

Temperature, Degrees F.	Weight in pounds per Cubic Foot.	Heat Units.	Temperature, Degrees F.	Weight in Pounds per Cubic Foot.	Heat Units.	Temperature, Degrees F.	Weight in Pounds per Cubic Foot.	Heat Units.	Temperature, Degrees F.	Weight in Pounds per Cubic Foot.	Heat Units.
32	62.42	0.00	78	62.25	46.03	124	61.67	92.17	170	60.77	138.45
34	62.42	2.00	80	62.23	48.04	126	61.63	94.17	172	60.73	140.47
36	62.42	4.00	82	62.21	50.04	128	61.60	96.18	174	60.68	142.49
38	62.42	6.00	84	62.19	52.04	130	61.56	98.19	176	60.64	144.51
40	62.42	8.00	86	62.17	54.05	132	61.52	100.20	178	60.59	146.52
42	62.42	10.00	88	62.15	56.05	134	61.49	102.21	180	60.55	148.54
44	62.42	12.00	90	62.13	58.06	136	61.45	104.22	182	60.50	150.56
46	62.42	14.00	92	62.11	60.06	138	61.41	106.23	184	60.46	152.58
48	62.41	16.00	94	62.09	62.06	140	61.37	108.25	186	60.41	154.60
50	62.41	18.00	96	62.07	64.07	142	61.34	110.26	188	60.37	156.62
52	62.40	20.00	98	62.05	66.07	144	61.30	112.27	190	60.32	158.64
54	62.40	22.01	100	62.02	68.08	146	61.26	114.28	192	60.27	160.67
56	62.39	24.01	102	62.00	70.09	148	61.22	116.29	194	60.22	162.69
58	62.38	26.01	104	61.97	72.09	150	61.18	118.31	196	60.17	164.71
60	62.37	28.01	106	61.95	74.10	152	61.14	120.32	198	60.12	166.73
62	62.36	30.01	108	61.92	76.10	154	61.10	122.33	200	60.07	168.75
64	62.35	32.01	110	61.89	78.11	156	61.06	124.35	202	60.02	170.78
66	62.34	34.02	112	61.86	80.12	158	61.02	126.36	204	59.97	172.80
68	62.33	36.02	114	61.83	82.13	160	60.98	128.37	206	59.92	174.83
70	62.31	38.02	116	61.80	84.13	162	60.94	130.39	208	59.87	176.85
72	62.30	40.02	118	61.77	86.14	164	60.90	132.41	210	59.82	178.87
74	62.28	42.03	120	61.74	88.15	166	60.85	134.42	212	59.76	180.90
76	62.27	44.03	122	61.70	90.16	168	60.81	136.44			

From Supplement to *Machinery*.

COMPARISON OF THERMOMETER SCALES.

Centigrade.	Reaumur.	Fahrenheit.	Centigrade.	Reaumur.	Fahrenheit.	Centigrade.	Reaumur.	Fahrenheit.
−30	−24.0	−22.0	14	11.2	57.2	58	46.4	136.4
−28	−22.4	−18.4	16	12.8	60.8	60	48.0	140.0
−26	−20.8	−14.8	18	14.4	64.4	62	49.6	143.6
−24	−19.2	−11.2	20	16.0	68.0	64	51.2	147.2
−22	−17.6	−7.6	22	17.6	71.6	66	52.8	150.8
−20	−16.0	−4.0	24	19.2	75.2	68	54.4	154.4
−18	−14.4	−0.4	26	20.8	78.8	70	56.0	158.0
−16	−12.8	3.2	28	22.4	82.4	72	57.6	161.6
−14	−11.2	6.8	30	24.0	86.0	74	59.2	165.2
−12	−9.6	10.4	32	25.6	89.6	76	60.8	168.8
−10	−8.0	14.0	34	27.2	93.2	78	62.4	172.4
−8	−6.4	17.6	36	28.8	96.8	80	64.0	176.0
−6	−4.8	21.2	38	30.4	100.4	82	65.6	179.6
−4	−3.2	24.8	40	32.0	104.0	84	67.2	183.2
−2	−1.6	28.4	42	33.6	107.6	86	68.8	186.8
0	0.0	32.0	44	35.2	111.2	88	70.4	190.4
2	1.6	35.6	46	36.8	114.8	90	72.0	194.0
4	3.2	39.2	48	38.4	118.4	92	73.6	197.6
6	4.8	42.8	50	40.0	122.0	94	75.2	201.2
8	6.4	46.4	52	41.6	125.6	96	76.8	204.8
10	8.0	50.0	54	43.2	129.2	98	78.4	208.4
12	9.6	53.6	56	44.8	132.8	100	80.0	212.0

From Supplement to *Machinery*.

Diam.	Circum.	Area.	Diam.	Circum.	Area.	Diam.	Circum.	Area.
1/64	.04909	.00019	2.1/8	6.6759	3.5466	5.7/8	17.082	23.221
1/32	.09818	.00077	1/8	6.8722	3.7583	1/2	17.279	23.758
3/64	.14726	.00173	1/4	7.0686	3.9761	1/8	17.475	24.301
1/16	.19635	.00307	1/8	7.2649	4.2000	5/8	17.671	24.850
5/64	.29452	.00690	3/8	7.4613	4.4301	1/4	17.868	25.406
1/8	.39270	.01227	1/8	7.6576	4.6664	3/4	18.064	25.967
9/64	.49087	.01917	1/2	7.8540	4.9087	1/8	18.261	26.535
5/32	.58905	.02761	1/8	8.0503	5.1572	7/8	18.457	27.109
11/64	.68722	.03758	5/8	8.2467	5.4119	1/4	18.653	27.688
			1/8	8.4430	5.6727			
1/4	.78540	.04909	3/4	8.6394	5.9396	6.	18.850	28.274
9/64	.88357	.06213	1/8	8.8357	6.2126	1/8	19.242	29.465
13/64	.98175	.07670	7/8	9.0321	6.4918	1/4	19.635	30.680
11/32	1.0799	.09281	1/4	9.2284	6.7771	3/8	20.028	31.919
23/64	1.1781	.11045				1/2	20.420	33.183
13/32	1.2763	.12962	3.	9.4248	7.0686	5/8	20.813	34.472
27/64	1.3744	.15033	1/8	9.6211	7.3662	3/4	21.206	35.785
15/32	1.4726	.17257	1/8	9.8175	7.6699	7/8	21.598	37.122
			1/4	10.014	7.9798			
1/2	1.5708	.19635	1/4	10.210	8.2958	7.	21.991	38.485
17/32	1.6690	.22166	1/8	10.407	8.6179	1/8	22.384	39.871
9/16	1.7671	.24850	3/8	10.603	8.9462	1/4	22.776	41.282
19/32	1.8653	.27688	1/8	10.799	9.2806	3/8	23.169	42.718
5/8	1.9635	.30680	1/2	10.996	9.6211	1/8	23.562	44.179
21/32	2.0617	.33824	5/8	11.192	9.9678	5/8	23.955	45.664
11/16	2.1598	.37122	3/4	11.388	10.321	3/4	24.347	47.173
23/32	2.2580	.40574	1/8	11.585	10.680	7/8	24.740	48.707
			1/4	11.781	11.045			
3/4	2.3562	.44179	1/8	11.977	11.416	8.	25.133	50.265
25/32	2.4544	.47937	1/8	12.174	11.793	1/8	25.525	51.849
13/16	2.5525	.51849	1/8	12.370	12.177	1/4	25.918	53.456
27/32	2.6507	.55914				3/8	26.311	55.088
7/8	2.7489	.60132	4.	12.566	12.566	1/2	26.704	56.745
29/32	2.8471	.64504	1/8	12.763	12.962	5/8	27.096	58.426
15/16	2.9452	.69029	1/8	12.959	13.364	3/4	27.489	60.132
31/32	3.0434	.73708	3/8	13.155	13.772	7/8	27.882	61.862
			1/4	13.352	14.186			
1	3.1416	.7854	1/8	13.548	14.607	9.	28.274	63.617
1/32	3.3379	.8866	1/8	13.744	15.033	1/8	28.667	65.397
1/16	3.5343	.9940	1/2	13.941	15.466	1/4	29.060	67.201
3/32	3.7306	1.1075	1/8	14.137	15.904	3/8	29.452	69.029
1/8	3.9270	1.2272	3/8	14.334	16.349	1/2	29.845	70.882
5/32	4.1233	1.3530	5/8	14.530	16.800	5/8	30.238	72.760
3/16	4.3197	1.4849	1/8	14.726	17.257	3/4	30.631	74.662
7/32	4.5160	1.6230	3/4	14.923	17.728	7/8	31.023	76.589
1/4	4.7124	1.7671	1/8	15.119	18.190			
9/32	4.9087	1.9175	7/8	15.315	18.665	10.	31.416	78.540
5/16	5.1051	2.0739	1/8	15.512	19.147	1/8	31.809	80.516
11/32	5.3014	2.2365				1/4	32.201	82.516
3/8	5.4978	2.4053	5.	15.708	19.635	3/8	32.594	84.541
13/32	5.6941	2.5802	1/8	15.904	20.129	1/2	32.987	86.590
7/16	5 8905	2.7612	1/8	16.101	20.629	5/8	33.379	88.664
15/32	6.0868	2.9483	3/8	16.297	21.135	3/4	33.772	90.763
			1/4	16.493	21.648	7/8	34.165	92.886
	6.2832	3.1416	1/8	16.690	22.166			
	6.4795	3 3410	3/8	16.886	22.691	11.	34.558	95.033

Diam.	Circum.	Area.	Diam.	Circum.	Area.	Diam.	Circum.	Area.
11.1/8	34.950	97.205	17.3/8	54.585	237.10	23.5/8	74.220	438.36
1/4	35.343	99.402	1/2	54.978	240.53	3/4	74.613	443.01
3/8	35.736	101.62	5/8	55.371	243.98	7/8	75.006	447.69
1/2	36.128	103.87	3/4	55.763	247.45			
5/8	36.521	106.14	7/8	56.156	250.95	24.	75.398	452.39
3/4	36.914	108.43				1/8	75.791	457.11
7/8	37.306	110.75	18.	56.549	254.47	1/4	76.184	461.86
			1/8	56.941	258.02	3/8	76.576	466.64
12.	37.699	113.10	1/4	57.334	261.59	1/2	76.969	471.44
1/8	38.092	115.47	3/8	57.727	265.18	5/8	77.862	476.26
1/4	38.485	117.86	1/2	58.119	268.80	3/4	77.754	481.11
3/8	38.877	120.28	5/8	58.512	272.45	7/8	78.147	485.98
1/2	39.270	122.72	3/4	58.905	276.12			
5/8	39.663	125.19	7/8	59.298	279.81	25.	78,540	490.87
3/4	40.055	127.68				1/8	78.933	495.79
7/8	40.448	130.19	19.	59.690	283.53	1/4	79.325	500.74
			1/8	60.083	287.27	3/8	79.718	505.71
13.	40.841	132.73	1/4	60.476	291.04	1/2	80.111	510.71
1/8	41.233	135.30	3/8	60.868	294.83	5/8	80.503	515.72
1/4	41.626	137.89	1/2	61.261	298.65	3/4	80.896	520.77
3/8	42.019	140.50	5/8	61.654	302.49	7/8	81.289	525.84
1/2	42.412	143.14	3/4	62.046	306.35			
5/8	42.804	145.80	7/8	62.439	310.24	26.	81.681	530.93
3/4	43.197	148.49				1/8	82.074	536.05
7/8	43.590	151.20	20.	62.832	314.16	1/4	82.467	541.19
			1/8	63.225	318.10	3/8	82.860	546.35
14.	43.982	153.94	1/4	63.617	322.06	1/2	83.252	551.55
1/8	44.375	156.70	3/8	64 010	326.05	5/8	83.645	556.76
1/4	44.768	159.48	1/2	64.403	330.06	3/4	84.038	562.00
3/8	45.160	162.30	5/8	64.795	334.10	7/8	84.430	567.27
1/2	45.553	165.13	3/4	65.188	338.16			
5/8	45.946	167.99	7/8	65.581	342.25	27.	84.823	572.56
3/4	46.338	170.87				1/8	85.216	577.87
7/8	46.731	173.78	21.	65.973	346.36	1/4	85.608	583.21
			1/8	66.366	350.50	3/8	86.001	588.57
15.	47.124	176.71	1/4	66.759	354.66	1/2	86.394	593.96
1/8	47.517	179.67	3/8	67.152	358.84	5/8	86.786	599.37
1/4	47.909	182.65	1/2	67.544	363.05	3/4	87.179	604.81
3/8	48.302	185.66	5/8	67.937	367.28	7/8	87.572	610.27
1/2	48.695	188.69	3/4	68.330	371.54			
5/8	49.087	191.75	7/8	68.722	375.83	28.	87.965	615.75
3/4	49.480	194.83				1/8	88.357	621.26
7/8	49.873	197.93	22.	69.115	380.13	1/4	88.750	626 80
			1/8	69.508	384.46	3/8	89.143	632.36
16.	50.265	201.06	1/4	69.900	388.82	1/2	89.535	637.94
1/8	50.658	204.22	3/8	70.293	393.20	5/8	89.928	643.55
1/4	51.051	207.39	1/2	70.686	397.61	3/4	90.321	649.18
3/8	51.444	210.60	5/8	71.079	402.04	7/8	90.713	654.84
1/2	51.836	213.82	3/4	71.471	406.49			
5/8	52.229	217.08	7/8	71.864	410.97	29.	91.106	660.52
3/4	52.622	220.35				1/8	91.499	666.23
7/8	53.014	223.65	23.	72.257	415.48	1/4	91.892	671.96
			1/8	72.649	420.00	3/8	92.284	677.71
17.	53.407	226.98	1/4	73.042	424.56	1/2	92.677	683.49
1/8	53.800	230.33	3/8	73.435	429.13	5/8	93.070	689.30
1/4	54.192	233.71	1/2	73.827	433.74	3/4	93.462	695.13

Diam.	Circum.	Area.	Diam.	Circum.	Area.	Diam.	Circum.	Area.
29.7/8	93.855	700.98	36.1/8	113.490	1025.0	42.3/8	133.125	1410.3
			1/4	113.883	1032.1	1/2	133.518	1418.6
30.	94.248	706.86	3/8	114.275	1039.2	5/8	133.910	1427.0
1/8	94.640	712.76	1/2	114.668	1046.3	3/4	134.303	1435.4
1/4	95.033	718.69	5/8	115.061	1053.5	7/8	134.696	1448.8
3/8	95.426	724.64	3/4	115.454	1060.7			
1/2	95.819	730.62	7/8	115.846	1068.0	43.	135.088	1452.2
5/8	96.211	736.62				1/8	135.481	1460.7
3/4	96.604	742.64	37.	116.239	1075.2	1/4	135.874	1469.1
7/8	96.997	748.69	1/8	116.633	1082.5	3/8	136.267	1477.6
			1/4	117.024	1089.8	1/2	136.659	1486.2
31.	97.389	754.77	3/8	117.417	1097.1	5/8	137.052	1494.7
1/8	97.782	760.87	1/2	117.810	1104.5	3/4	137.445	1508.3
1/4	98.175	766.99	5/8	118.202	1111.8	7/8	137.837	1511.9
3/8	98.567	773.14	3/4	118.596	1119.2			
1/2	98.960	779.31	7/8	118.988	1126.7	44.	138.230	1520.5
5/8	99.353	785.51				1/8	138.623	1529.2
3/4	99.746	791.78	38.	119.381	1134.1	1/4	139.015	1537.9
7/8	100.138	797.98	1/8	119.773	1141.6	3/8	139.408	1546.6
			1/4	120.166	1149.1	1/2	139.801	1555.3
32.	100.531	804.25	3/8	120.559	1156.6	5/8	140.194	1564.0
1/8	100.924	810.54	1/2	120.951	1164.2	3/4	140.586	1572.8
1/4	101.316	816.86	5/8	121.344	1171.7	7/8	140.979	1581 6
3/8	101.709	823.21	3/4	121.737	1179.3			
1/2	102.102	829.58	7/8	122.129	1186.9	45.	141.372	1590.4
5/8	102.494	835.97				1/8	141.764	1599.3
3/4	102.887	842.39	39.	122.522	1194.6	1/4	142.157	1608.2
7/8	103.280	848.83	1/8	122.915	1202.3	3/8	142.550	1617.0
			1/4	123.308	1210.0	1/2	142.942	1626.0
33.	103.673	855.30	3/8	123.700	1217.7	5/8	143.335	1634.9
1/8	104.065	861.79	1/2	124.093	1225.4	3/4	143.728	1643.9
1/4	104.458	868.31	5/8	124.486	1233.2	7/8	144.121	1652.9
3/8	104.851	874.85	3/4	124.878	1241.0			
1/2	105.243	881.41	7/8	125.271	1248.8	46.	144.513	1661.9
5/8	105.636	888.00				1/8	144.906	1670.9
3/4	106.029	894.62	40.	125.664	1256.6	1/4	145.299	1680.0
7/8	106.421	901.26	1/8	126.056	1264.5	3/8	145.691	1689.1
			1/4	126.449	1272.4	1/2	146.084	1698.2
34.	106.814	907.92	3/8	126.842	1280.3	5/8	146.477	1707.4
1/8	107.207	914.61	1/2	127.235	1288.2	3/4	146.869	1716.5
1/4	107.600	921.32	5/8	127.627	1296.2	7/8	147.262	1725.7
3/8	107.992	928.06	3/4	128.020	1304.2			
1/2	108.385	934.82	7/8	128.413	1312.2	47.	147.655	1734.9
5/8	108.778	941.61				1/8	148.048	1744.2
3/4	109.170	948.42	41.	128.805	1320.3	1/4	148.440	1753.5
7/8	109.563	955.25	1/8	129.198	1328.3	3/8	148.833	1762.7
			1/4	129.591	1336.4	1/2	149.226	1772.1
35.	109.956	962.11	3/8	129.983	1344.5	5/8	149.618	1781.4
1/8	110.348	969.00	1/2	130.376	1352.7	3/4	150.011	1790.8
1/4	110.741	975.91	5/8	130.769	1360.8	7/8	150.404	1800.1
3/8	111.134	982.84	3/4	131.161	1369.0			
1/2	111.527	989.80	7/8	131.554	1377.2	48.	150.796	1809.6
5/8	111.919	996.78				1/8	151.189	1819.0
3/4	112.312	1003.8	42.	131.947	1385.4	1/4	151.582	1828.5
7/8	112.705	1010.8	1/8	132.340	1393.7	3/8	151.975	1837.9
36.	113.097	1017.9	1/4	132.732	1402.0	1/2	152.367	1847.5

Diam.	Circum.	Area.	Diam.	Circum.	Area.	Diam.	Circum.	Area.
48.	152.760	1857.0	54.	172.395	2365.0	61.	191.637	2922.5
1/8	153.152	1866.5	1/8			1/8	192.030	2934.5
1/4	153.545	1876.1	1/4	172.788	2375.8	1/4	192.423	2946.5
3/8			3/8	173.180	2386.6	3/8	192.815	2958.5
49.	153.938	1885.7	1/2	173.573	2397.5	1/2	193.208	2970.6
1/8	154.331	1895.4	5/8	173.966	2408.3	5/8	193.601	2982.7
1/4	154.723	1905.0	3/4	174.358	2419.2	3/4	193.993	2994.8
3/8	155.116	1914.7	7/8	174.751	2430.1	7/8	194.386	3006.9
1/2	155.509	1924.4	55.	175.144	2441.1			
5/8	155.902	1934.2	1/8	175.536	2452.0	62.	194.779	3019.1
3/4	156.294	1943.9	1/4			1/8	195.171	3031.3
7/8	156.687	1953.7	3/8	175.929	2463.0	1/4	195.564	3043.5
50.	157.080	1963.5	1/2	176.322	2474.0	3/8	195.957	3055.7
1/8	157.472	1973.3	5/8	176.715	2485.0	1/2	196.350	3068.0
1/4	157.865	1983.2	3/4	177.107	2496.1	5/8	196.742	3080.3
3/8	158.258	1993.1	7/8	177.500	2507.2	3/4	197.135	3092.6
1/2	158.650	2003.0	56.	177.893	2518.3	7/8	197.528	3104.9
5/8	159.043	2012.9	1/8	178.285	2529.4			
3/4	159.436	2022.8	1/4	178.678	2540.6	63.	197.920	3117.2
7/8	159.829	2032.8	3/8			1/8	198.313	3129.6
51.	160.221	2042.8	1/2	179.071	2551.8	1/4	198.706	3142.0
1/8	160.614	2052.8	5/8	179.463	2563.0	3/8	199.098	3154.5
1/4	161.007	2062.9	3/4	179.856	2574.2	1/2	199.491	3166.9
3/8	161.399	2073.0	7/8	180.249	2585.4	5/8	199.884	3179.4
1/2	161.792	2083.1	57.	180.642	2596.7	3/4	200.277	3191.9
5/8	162.185	2093.2	1/8	181.034	2608.0	7/8	200.669	3204.4
3/4	162.577	2103.3	1/4	181.427	2619.4			
7/8	162.970	2113.5	3/8	181.820	2630.7	64.	201.062	3217.0
52.	163.363	2123.7	1/2	182.212	2642.1	1/8	201.455	3229.6
1/8	163.756	2133.9	5/8	182.605	2653.5	1/4	201.847	3242.2
1/4	164.148	2144.2	3/4	182.998	2664.9	3/8	202.240	3254.8
3/8	164.541	2154.5	7/8	183.390	2676.4	1/2	202.633	3267.5
1/2	164.934	2164.8	58.	183.783	2687.8	5/8	203.025	3280.1
5/8	165.326	2175.1	1/8	184.176	2699.3	3/4	203.418	3292.8
3/4	165.719	2185.4	1/4	184.569	2710.9	7/8	203.811	3305.6
7/8	166.112	2195.8	3/8	184.961	2722.4	65.	204.204	3318.3
53.	166.504	2206.2	1/2	185.354	2734.0	1/8	204.596	3331.1
1/8	166.897	2216.6	5/8	185.747	2745.6	1/4	204.989	3343.9
1/4	167.290	2227.0	3/4	186.139	2757.2	3/8	205.382	3356.7
3/8	167.683	2237.5	7/8	186.532	2768.8	1/2	205.774	3369.6
1/2	168.075	2248.0	59.	186.925	2780.5	5/8	206.167	3382.4
5/8	168.468	2258.5	1/8	187.317	2792.2	3/4	206.560	3395.3
3/4	168.861	2269.1	1/4	187.710	2803.9	7/8	206 952	3408.2
7/8	169.253	2279.6	3/8	188.103	2815.7	66.	207.345	3421.2
54.	169.646	2290.2	1/2	188.496	2827.4	1/8	207.738	3434.2
1/8	170.039	2300.8	5/8	188.888	2839.2	1/4	208.131	3447.2
1/4	170.431	2311.5	3/4	189.281	2851.0	3/8	208.523	3460.2
3/8	170.824	2322.1	7/8	189.674	2862.9	1/2	208.916	3473.2
1/2	171 217	2332.8	60.	190.066	2874.8	5/8	209.309	3486.3
5/8	171.609	2343.5	1/8	190.459	2886.6	3/4	209.701	3499.4
3/4	172.002	2354.3	1/4	190.852	2898.6	7/8	210.094	3512.5
			3/8	191.244	2910.5	67.	210.487	3525.7
						1/8	210.879	3538.8

Diam.	Circum.	Area.	Diam.	Circum.	Area.	Diam.	Circum.	Area.
67.1/4	211.272	3552.0	73.1/8	230.907	4242.9	79.3/4	250.542	4995.2
3/8	211.665	3565.2	1/4	231.300	4257.4	7/8	250.935	5010.9
1/2	212.058	3578.5	3/8	231.692	4271.8			
5/8	212.450	3591.7	7/8	232.085	4286.3	80.	251.327	5026.5
3/4	212.843	3605.0				1/8	251.720	5042.3
7/8	213.236	3618.3	74.	232.478	4300.8	1/4	252.113	5058.0
68.	213.628	3631.7	1/8	232.871	4315.4	3/8	252.506	5073.8
1/8	214.021	3645.0	1/4	233.263	4329.9	1/2	252.898	5089.6
1/4	214.414	3658.4	3/8	233.656	4344.5	5/8	253.291	5105.4
3/8	214.806	3671.8	1/2	234.049	4359.2	3/4	253.684	5121.2
1/2	215.199	3685.3	5/8	234.441	4373.8	7/8	254.076	5137.1
5/8	215.592	3698.7	3/4	234.834	4388.5			
3/4	215.984	3712.2	7/8	235.227	4403.1	81.	254.469	5153.0
7/8	216.377	3725.7	75.	235.619	4417.9	1/8	254.862	5168.9
69.	216.770	3739.3	1/8	236.012	4432.6	1/4	255.254	5184.9
1/8	217.163	3752.8	1/4	236.405	4447.4	3/8	255.647	5200.8
1/4	217.555	3766.4	3/8	236.798	4462.2	1/2	256.040	5216.8
3/8	217.948	3780.0	1/2	237.190	4477.0	5/8	256.433	5232.8
1/2	218.341	3793.7	5/8	237.583	4491.8	3/4	256.825	5248.9
5/8	218.733	3807.3	3/4	237.976	4506.7	7/8	257.218	5264.9
3/4	219.126	3821.0	7/8	238.368	4521.5			
7/8	219.519	3834.7	76.	238.761	4536.5	82.	257.611	5281.0
70.	219.911	3848.5	1/8	239.154	4551.4	1/8	258.003	5297.1
1/8	220.304	3862 2	1/4	239.546	4566.4	1/4	258.396	5313.3
1/4	220.697	3876.0	3/8	239.939	4581.3	3/8	258.789	5329.4
3/8	221.090	3889.8	1/2	240.332	4596.3	1/2	259.181	5345.6
1/2	221.482	3903.6	5/8	240.725	4611.4	5/8	259.574	5361.8
5/8	221.875	3917.5	3/4	241.117	4626.4	3/4	259.967	5378.1
3/4	222.268	3931.4	7/8	241.510	4641.5	7/8	260.359	5394 3
7/8	222.660	3945.3	77.	241.903	4656.6	83.	260.752	5410.6
71.	223.052	3959.3	1/8	242.295	4671.8	1/8	261.145	5426.9
1/8	223.446	3973.1	1/4	242.688	4686.9	1/4	261.538	5443.3
1/4	223.838	3987.1	3/8	243.081	4702.1	3/8	261.930	5459.6
3/8	224.231	4001.1	1/2	243.473	4717.3	1/2	262.323	5476.0
1/2	224.624	4015.2	5/8	243.866	4732.5	5/8	262.716	5492.4
5/8	225.017	4029.2	3/4	244.259	4747.8	3/4	263.108	5508.8
3/4	225.409	4043.3	7/8	244.652	4763.1	7/8	263.501	5525.3
7/8	225.802	4057.4	78.	245.044	4778.4	84.	263.894	5541.8
72.	226.195	4071.5	1/8	245.437	4793.7	1/8	264.286	5558.3
1/8	226.587	4085.7	1/4	245.830	4809.0	1/4	264.679	5574.8
1/4	226.980	4099.8	3/8	246.222	4824.4	3/8	265.072	5591.4
3/8	227.373	4114.0	1/2	246.615	4839.8	1/2	265.465	5607.9
1/2	227.765	4128.2	5/8	247.008	4855.2	5/8	265.857	5624.5
5/8	228.158	4142.5	3/4	247.400	4870.7	3/4	266.250	5641.2
3/4	228.551	4156.8	7/8	247.793	4886.2	7/8	266.643	5657.8
7/8	228.944	4171.1	79.	248.186	4901.7	85.	267.035	5674.5
73.	229.336	4185.4	1/8	248.579	4917.2	1/8.	267.428	5691.2
1/8	229.729	4199.7	1/4	248.971	4932.7	1/4	267.821	5707.9
1/4	230.122	4214.1	3/8	249.364	4948.3	3/8	268.213	5724.7
3/8	230.514	4228.5	1/2	249.757	4963 9	1/2	268.606	5741.5
			5/8	250.149	4979.5	5/8	268.999	5758.3
						3/4	269.392	5775.1
						7/8	269.784	5791.9

Diam.	Circum.	Area.	Diam.	Circum.	Area.	Diam.	Circum.	Area.
86.	270.177	5808.8	90.7/8	285.492	6486.0	95.5/8	300.415	7181.8
1/8	270.570	5825.7				3/4	300.807	7200.6
1/4	270.962	5842.6	91.	285.885	6503.9	7/8	301.200	7219.4
3/8	271.355	5859.6	1/8	286.278	6521.8			
1/2	271.748	5876.5	1/4	286.670	6539.7	96.	301.593	7238.2
5/8	272.140	5893.5	3/8	287.063	6557.6	1/8	301.986	7257.1
3/4	272.533	5910.6	1/2	287.456	6575.5	1/4	302.378	7276.0
7/8	272.926	5927.6	5/8	287.848	6593.5	3/8	302.771	7294.9
			3/4	288.241	6611.5	1/2	303.164	7313.8
87.	273.319	5944.7	7/8	288.634	6629.6	5/8	303.556	7332.8
1/8	273.711	5961.8				3/4	303.949	7351.8
1/4	274.104	5978.9	92.	289.027	6647.6	7/8	304.342	7370.8
3/8	274.497	5996.0	1/8	289.419	6665.7			
1/2	274.889	6013.2	1/4	289.812	6683.8	97.	304.734	7389.8
5/8	275.282	6030.4	3/8	290.205	6701.9	1/8	305.127	7408.9
3/4	275.675	6047.6	1/2	290.597	6720.1	1/4	305.520	7428.0
7/8	276.067	6064.9	5/8	290.990	6738.2	3/8	305.913	7447.1
			3/4	291.383	6756.4	1/2	306.305	7466.2
88.	276.460	6082.1	7/8	291.775	6774.7	5/8	306.698	7485.3
1/8	276 853	6099.4				3/4	307.091	7504.5
1/4	277.246	6116.7	93.	292.168	6792.9	7/8	307.483	7523.7
3/8	277.638	6134.1	1/8	292.561	6811.2			
1/2	278.031	6151.4	1/4	292.954	6829.5	98.	307.876	7543.0
5/8	278.424	6168.8	3/8	293.346	6847.8	1/8	308.269	7562.2
3/4	278.816	6186.2	1/2	293.739	6866.1	1/4	308.661	7581.5
7/8	279.209	6203.7	5/8	294.132	6884.5	3/8	309.054	7600.8
			3/4	294.524	6902.9	1/2	309.447	7620.1
89.	279.602	6221.1	7/8	294.917	6921 3	5/8	309.840	7639.5
1/8	279.994	6238.6				3/4	310.232	7658.9
1/4	280.387	6256.1	94.	295.310	6939.8	7/8	310.625	7678.3
3/8	280.780	6273.7	1/8	295.702	6958.2			
1/2	281.173	6291.2	1/4	296.095	6976.7	99.	311.018	7697.7
5/8	281.565	6308.8	3/8	296.488	6995.3	1/8	311.410	7717.1
3/4	281.958	6326 4	1/2	296.881	7013.8	1/4	311.803	7736.6
7/8	282.351	6344.1	5/8	297.273	7032.4	3/8	312.196	7756.1
			3/4	297.666	7051.0	1/2	312.588	7775.6
90.	282.743	6361.7	7/8	298.059	7069.6	5/8	312.981	7795.2
1/8	283.136	6379.4				3/4	313.374	7814.8
1/4	283.529	6397.1	95.	298.451	7088.2	7/8	313.767	7834.4
3/8	283.921	6414.9	1/8	298.844	7106.9			
1/2	284.314	6432.6	1/4	299.237	7125.6	100.	314.159	7854.0
5/8	284.707	6450.4	3/8	299.629	7144.3			
3/4	285.100	6468.2	1/2	300.022	7163.0			

Diameter × 3.1416 = circumference.
" × 0.8862 = side of an equivalent square.
" × 0.7071 = side of an inscribed square.
(Diameter)² × 0.7854 = area of circle.
Radius × 6.2832 = circumference.
Circumference ÷ 3.1416 = diameter.

Decimal Equivalents.

1–64	.015625	17–64	.265625	33–64	.515625	49–64	.765625
1–32	.03125	9–32	.28125	17–32	.53125	25–32	.78125
3–64	.046875	19–64	.296875	35–64	.546875	51–64	.796875
1-16	.0625	**5-16**	.3125	**9-16**	.5625	**13-16**	.8125
5–64	.078125	21–64	.328125	37–64	.578125	53–64	.828125
3–32	.09375	11–32	.34375	19–32	.59375	27–32	.84375
7–64	.109375	23–64	.359375	39–64	.609375	55–64	.859375
1-8	.125	**3-8**	.375	**5-8**	.625	**7-8**	.875
9–64	.140625	25–64	.390625	41–64	.640625	57–64	.890625
5–32	.15625	13–32	.40625	21–32	.65625	29–32	.90625
11–64	.171875	27–64	.421875	43–64	.671875	59–64	.921875
3-16	.1875	**7-16**	.4375	**11-16**	.6875	**15-16**	.9375
13–64	.203125	29–64	.453125	45–64	.703125	61–64	.953125
7–32	.21875	15–32	.46875	23–32	.71875	31–32	.96875
15–64	.234375	31–64	.484375	47–64	.734375	63–64	.984375
1-4	.25	**1-2**	.50	**3-4**	.75	**1**	

Lengths of Threads Cut on Bolts.

Length of Bolts,	$\frac{1}{4}$ & $\frac{5}{16}$	$\frac{3}{8}$	$\frac{7}{16}$ & $\frac{1}{2}$	$\frac{9}{16}$ & $\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1	$1\frac{1}{8}$	$1\frac{1}{4}$
1 to $1\frac{1}{2}$ in.	$\frac{3}{4}$	$\frac{3}{4}$	1	$1\frac{1}{4}$	.....	.....	.....	.....	.....
$1\frac{5}{8}$ " 2 "	$\frac{3}{4}$	$\frac{3}{4}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{1}{2}$	.....	.....	.....
$2\frac{1}{8}$ " $2\frac{1}{2}$ "	$\frac{3}{4}$	$\frac{3}{4}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	$1\frac{3}{4}$	.....	.....
$2\frac{5}{8}$ " 3 "	$\frac{7}{8}$	$\frac{7}{8}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	$1\frac{3}{4}$	$2\frac{1}{4}$	.....
$3\frac{1}{8}$ " 4 "	$\frac{7}{8}$	$\frac{7}{8}$	$1\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	$1\frac{3}{4}$	$2\frac{1}{4}$	$2\frac{1}{2}$
$4\frac{1}{8}$ " 8 "	1	1	$1\frac{1}{4}$	$1\frac{3}{4}$	$1\frac{3}{4}$	2	$2\frac{1}{4}$	$2\frac{1}{2}$	$2\frac{3}{4}$
$8\frac{1}{8}$ " 12 "	1	1	$1\frac{1}{2}$	$1\frac{3}{4}$	2	$2\frac{1}{4}$	$2\frac{1}{2}$	3	3
$12\frac{1}{8}$ " 20 "	1	1	$1\frac{1}{2}$	2	2	$2\frac{1}{4}$	$2\frac{1}{2}$	3	3

Bolts longer than 20 inches and larger than 1¼ inches in diameter will be threaded about 3 times the diameter of the rod.

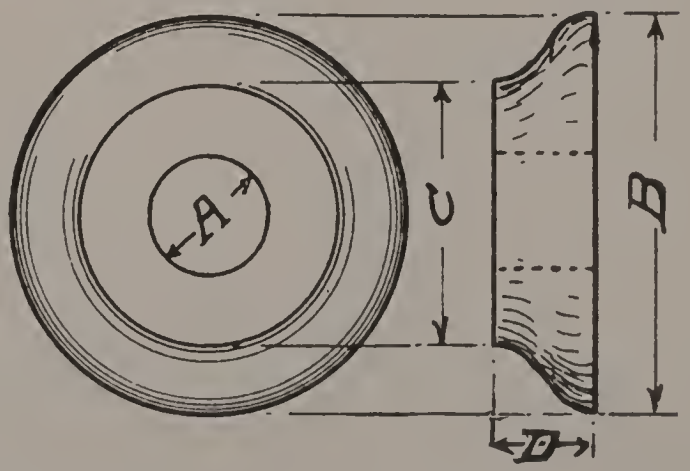
Weight of Nuts, Bolt heads and Round bars in pounds.

Dia. of Bolt	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{3}{4}$	2	$2\frac{1}{2}$	3
Weight of Hex. Nut and Head	.017	.067	.128	.267	.43	.73	1.10	2.14	3.78	5.6	8.75	17.0	28.8
Weight. of Sq. Nut and Head	.021	.079	.164	.320	.55	.88	1.31	2.56	4.42	7.0	10.5	21.0	36.4
Weight of Hex Nut & Sq. Head	.019	.061	.144	.321	.542	.75	1.01	2.45	3.58	5.7	7.5	17.8	31.8
Weight of Round Bar per foot	.167	.375	.667	1.043	1.502	2.044	2.670	4.173	6.008	8.178	13.60	21.25	30.60

U. S. STANDARD SCREW THREADS.

Nominal Diameter of Screw.		Number of Threads per inch.	Diameter of Tap at Root of Thread.		Size of Tap Drill, giving a Clearance of 1/8 the Height of the Original Thread Triangle.		Area at Root of Thread.	Safe Load on Threaded Bolt on basis of 6,000 lbs. Stress per sq. In. of Section at Root of Thread.
Inches.	Inches.		Inches.	Nearest 64ths.	Inches.	Nearest 64ths.	Sq. In.	Pounds.
1/4	.250	20	.185	3/16 −	.196	13/64 −	.027	162
5/16	.312	18	.240	15/64 +	.252	1/4 +	.045	270
3/8	.375	16	.294	19/64 −	.307	5/16 −	.068	408
7/16	.437	14	.345	11/32 +	.360	23/64 +	.093	558
1/2	.500	13	.400	13/32 −	.417	27/64 −	.126	756
9/16	.562	12	.454	29/64 +	.472	15/32 +	.162	997
5/8	.625	11	.507	1/2 +	.527	17/32 −	.202	1210
11/16	.687	11	.569	9/16 +	.589	19/32 −	.254	1520
3/4	.750	10	.620	5/8 −	.642	41/64 +	.302	1810
13/16	.812	10	.683	11/16 −	.704	45/64 +	.366	2190
7/8	.875	9	.731	47/64 −	.755	3/4 +	.420	2520
15/16	.937	9	.793	51/64 −	.817	13/16 +	.494	2960
1	1.000	8	.838	27/32 −	.865	55/64 +	.551	3300
1 1/16	1.062	8	.900	29/32 −	.927	59/64 +	.636	3810
1 1/8	1.125	7	.939	15/16 +	.970	31/32 +	.694	4160
1 3/16	1.187	7	1.002	1 +	1.032	1 1/32 +	.788	4720
1 1/4	1.250	7	1.064	1 1/16 +	1.095	1 3/32 +	.893	5350
1 3/8	1.375	6	1.158	1 5/32 +	1.215	1 7/32 −	1.057	6340
1 1/2	1.500	6	1.283	1 9/32 +	1.345	1 11/32 +	1.295	7770
1 5/8	1.625	5 1/2	1.389	1 25/64 −	1.428	1 27/64 +	1.515	9090
1 3/4	1.750	5	1.490	1 31/64 +	1.534	1 17/32 +	1.746	10470
1 7/8	1.875	5	1.615	1 39/64 +	1.659	1 21/32 +	2.051	12300
2	2.000	4 1/2	1.711	1 23/32 −	1.760	1 49/64 −	2.302	13800
2 1/4	2.250	4 1/2	1.961	1 61/64 +	2.010	2 1/64 −	3.023	18100
2 1/2	2.500	4	2.175	2 11/64 +	2.230	2 15/64 −	3.719	22300
2 3/4	2.750	4	2.425	2 27/64 +	2.480	2 31/64 −	4.620	27700
3	3.000	3 1/2	2.629	2 5/8 +	2.691	2 11/16 +	5.428	32500
3 1/4	3.250	3 1/2	2.879	2 7/8 +	2.941	2 15/16 +	6.510	39000
3 1/2	3.500	3 1/4	3.100	3 3/32 +	3.167	3 11/64 −	7.548	45300
3 3/4	3.750	3	3.317	3 5/16 +	3.389	3 25/64 −	8.641	51800
4	4.000	3	3.567	3 9/16 +	3.639	3 41/64 −	9.963	59700

Cast Iron Washers.



BOLT	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	2	2 1/4
A	9/16	11/16	13/16	15/16	1 1/16	1 3/16	1 5/16	1 7/16	1 9/16	1 11/16	1 13/16	1 15/16	2 1/16	2 5/16
B	2	2 1/2	3	3 1/2	4	4 1/2	5	5 1/2	6	6 1/2	7	7 1/4	7 1/2	7 3/4
C	1 1/4	1 1/2	2	2 1/4	2 5/8	2 7/8	3 1/4	3 1/2	3 3/4	4	4 1/4	4 1/2	4 3/4	5
D	3/8	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 7/16	1 1/2	1 9/16	1 5/8	1 3/4
Weight per 100	21	43	70	113	175	256	332	455	610	737	865	990	1115	1350

L. of C.

STANDARD SIZES					ADDITIONAL SIZES					RIVETING				SQUARE					WOOD				EXTRA SIZES.			
Dia. of Bolt	Out-side Dia.	Thick-ness	Size of Hole	Number in 100 lbs.	Dia. of Bolt	Out-side Dia.	Thick-ness	Size of Hole	Number in 100 lbs.	Dia. of Bolt	Out-side Dia.	Thick-ness Bolt.	Size of Hole	Dia. of Bolt	One Side	Thick-ness	Size of Hole	Number in 100 lbs.	Out-side Dia.	Thick-ness	Size of Hole	Number in 100 lbs.	Dia. of Bolt	Out-side Dia.	Thick-ness	Size of Hole.
3/16	9/16	18	1/4	39400	3/16	1/2	18	1/4	45500	#8	1/2	18	1/64 Scant Over Size	1/4	...	...	...	.....	7/8	14	5/16	9400	1/4	9/16	16	5/16
1/4	3/4	16	5/16	13900	1/4	5/8	16	5/16	21500	#6	9/16	18		5/16	...	...	...	.....	1	12	3/8	5000	3/8	3/4	16	7/16
5/16	7/8	16	3/8	11250	5/16	3/4	16	3/8	16500	#5	5/8	18		3/8	1 1/2	1/8	7/16	1300	1 1/8	12	7/16	4000	7/16	7/8	14	1/2
3/8	1	14	9/16	6800	3/8	7/8	14	7/16	11500	1/4	5/8	16	1/64	3/8	...	...	...	.....	1 1/4	12	7/16	3250	1/2	1	14	9/16
7/16	1 1/4	14	1/2	4300	7/16	1	14	1/2	7400	1/4	3/4	16	9/32	3/8	...	...	...	.....	1 1/2	11	7/16	2050	1/2	1/16	12	9/16
1/2	1 3/8	12	9/16	2600	7/16	1 1/8	14	1/2	5450	5/16	3/4	14	11/32	7/16	1 3/4	1/8	1/2	1100	1 1/4	12	1/2	3400	5/8	1 1/8	12	11/16
9/16	1 1/2	12	5/8	2250	1/2	1 1/8	12	9/16	4800	5/16	7/8	14	11/32	7/16	...	...	...	.....	1 1/2	11	1/2	2000	5/8	1 3/8	10	11/16
5/8	1 3/4	10	11/16	1300	1/2	1 1/4	12	9/16	3650	3/8	7/8	14	13/32	1/2	2	3/16	9/16	500	1 1/2	11	9/16	2050	3/4	1 3/8	10	13/16
3/4	2	10	13/16	1010	1/2	1 1/2	12	9/16	2000	3/8	1	14	13/32	1/2	...	...	...	.....	1 3/4	10	9/16	1300	3/4	1 5/8	10	13/16
7/8	2 1/4	10	15/16	860	9/16	1 1/4	12	5/8	3900	3/8	1 1/4	12	13/32	1/2	...	...	...	.....	2	10	9/16	940	7/8	1 3/4	10	15/16
1	2 1/2	9	1 1/16	625	9/16	1 3/8	12	5/8	3000	7/16	1	14	15/32	9/16	...	...	...	.....	1 3/4	10	5/8	1350	7/8	1 7/8	10	15/16
1 1/8	2 3/4	9	1 1/4	520	5/8	1 1/4	12	11/16	4100	7/16	1 1/4	12	15/32	5/8	2 1/2	1/4	23/32	315	2	10	11/16	960	1	1 3/4	10	1/16
1 1/4	3	9	1 3/8	400	5/8	1 3/8	12	11/16	3200	1/2	1 1/8	12	17/32	5/8	...	...	...	.....	2 1/4	10	11/16	800	1	2	9	1/16
1 3/8	3 1/2	8	1 1/2	280	5/8	1 1/2	10	11/16	2150	1/2	1 1/4	12	17/32	3/4	2 1/2	1/4	27/32	250	2 1/4	10	13/16	825	1 1/8	2	9	1/4
1 1/2	3 3/4	8	1 5/8	240	3/4	1 1/2	10	13/16	2200	1/2	1 1/2	11	17/32	7/8	3	1/4	31/32	165	2 1/2	10	15/16	650	1 1/8	2 1/4	9	1/4
1 5/8	3 3/4	8	1 3/4	245	3/4	1 3/4	10	13/16	1400	5/8	1 1/2	11	21/32	1	3 1/2	3/8	1 3/32	87	3	8	1 1/16	480	1 1/8	2 1/2	9	1/4
1 3/4	4	8	1 7/8	220	7/8	2	9	15/16	1150	5/8	1 3/4	10	21/32	1 1/8	4	3/8	1 1/4	65					1 1/4	2 1/2	9	1 3/8
1 7/8	4 1/4	8	2	190	1	2 1/4	9	1 1/16	940					1 1/4	4 1/2	3/8	1 3/8	48					1 1/4	2 3/4	9	1 3/8
2	4 1/2	8	2 1/8	175										1 3/8	5	3/8	1 1/2	40					1 3/8	3	9	1 1/2
2 1/4	4 3/4	6	2 3/8	110										1 1/2	6	3/8	1 5/8	28					1 1/2	3	8	1 5/8
2 1/2	5	6	2 5/8	91	THICKNESS IN INCHES.									1 3/4	6 1/2	3/8	1 7/8	24					1 1/2	3 1/4	8	1 5/8
					GAUGE	18	16	14	12	10	9	8	6	2	7	3/8	2 1/8	21					1 3/4	3 1/2	8	1 7/8
					INCHES	3/64	1/16	5/64	3/32	1/8	5/32	11/64	7/32										1 1/4	3 3/4	8	1 7/8
Copied by C.F.S.																							2	4	8	2 1/8

SIZES FOR BOILER FEED PUMPS.

Diam. Steam Cyl.	Diam. Water Cyl.	Stroke	Horse-Power Boilers.	Steam Pipe	Exh'st Pipe	Suct'n Pipe	Dischg Pipe
3½	2¼	4	30– 40	⅜	½	1	¾
4½	2¾	4	80–100	½	¾	2	1¼
5½	3½	5	140–160	¾	1¼	2½	1½

SIZES OF BOILER FITTINGS.

HORSE-POWER----	30	35	40	45	50	55	60	70	75	85	100	125
	In	In	In	In	In	In	In	In	In	In	In	In
Blow-off Pipe-----	1½	1½	1½	1½	1½	2	2	2	2	2½	2½	2½
Blow-off Cock----	1¼	1¼	1¼	1¼	1¼	1½	1½	1½	1½	2	2	2
Feed-valve and Check-valve-----	1	1	1	1	1	1¼	1¼	1¼	1¼	1½	1½	1½

MEMORANDUM.

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